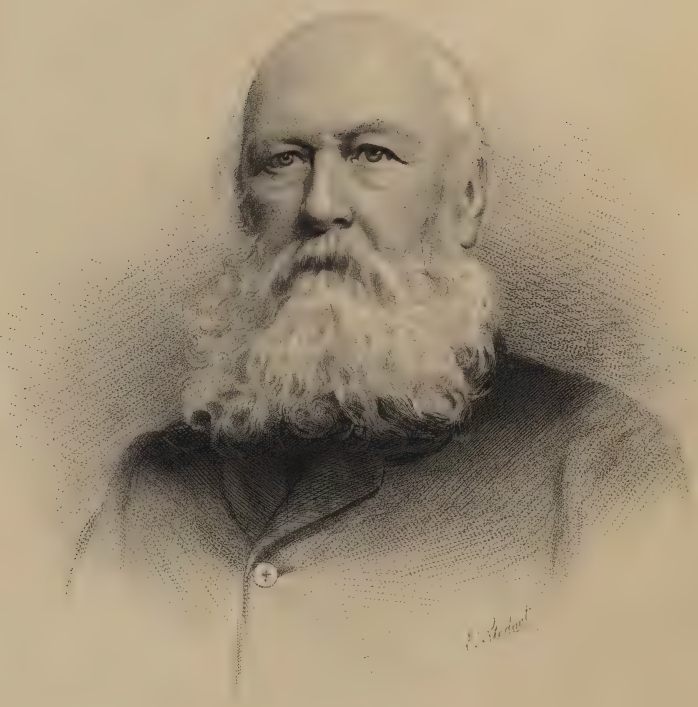
FERN GROWING

E. J. LOWE, F.R.S.



E. J. Lowe

FERN GROWING

FIFTY YEARS' EXPERIENCE IN CROSSING AND CULTIVATION

WITH A LIST OF THE MOST IMPORTANT VARIETIES AND A HISTORY OF THE DISCOVERY OF MULTIPLE PARENTAGE, ETC.

BY

E. J. LOWE, F.R.S., F.L.S., ETC.

AUTHOR OF

"OUR NATIVE FERNS," "BRITISH AND EXOTIC FERNS" ETC., ETC.

WITH SIXTY-TWO ILLUSTRATIONS

LONDON

JOHN C. NIMMO

14 KING WILLIAM STREET, STRAND

MDCCCXCV

Printed by BALLANTYNE, HANSON & CO.
At the Ballantyne Press

Dedication

Dear Mr. Moly,

It is with a sense of gratification, heightened by the consciousness of fitness and duty, that I have dedicated to you this record of observations and experiments in a department of inquiry to which you have so largely contributed, and in the prosecution of which you have so often assisted.

A number of experiments at first confined to the investigation of the crossing of Ferns, has gradually resulted in the establishment of an ordered series of facts materially affecting our conceptions of Pteridology.

At a time when the first disclosure of these facts was received with general incredulity, I was encouraged to persevere in my inquiries by the diligent co-operation of our able friends Colonel Jones, Abraham Clapham, Major Cowburn, and Edwin Fox. These, alas! have all passed away; but to you, as to one whose assistance has been as continuous as your discoveries have been invaluable, it is still permitted me to render this tribute of esteem.

To one who has devoted his life to the enrichment of our knowledge of English Ferns, the dedication of this record of the results of fifty years' labour in the investigation of the mysteries of Cryptogamic parentage seems to me to be most due.

Believe me,

Yours very sincerely,

E. J. LOWE.

Do Not Remove This Card From The Pocket.

Do NOT write above this line.

Call-no:
3842.62

AUTHOR:
LOWE, EDWARD J.

TITLE:
FERN GROWING

Signature of Reader
Mary Hartel

Address
404 Saratoga

BOOK STACK SERVICE

Boston Public Library
(Over)

FORM No. 1178.—

SEAT NO.
24.

For assistance please consult Library Staff.

REPORT

- ☐ Copies .....
- ☐ Out .....
- ☐ Bindery .....
- ☐ Missing .....
- ☐ Not on Shelf.....
- ☐ In .....
  .....
- ☐ Please consult Library Staff for further information

Attendant's Initials:

(Over)

PREFACE

IT may be profitable to describe what the author has been able to achieve in an experience dating back to 1842, not only in crossing Ferns, but in his experiments in the hybridisation of other plants. These embrace the Fuchsia, Pansy, Cactus, Dahlia, Aquilegia, Centaurea, Camelia, Primrose, Oxlip, Narcissus, Mimulus, Chrysanthemum, Currant, Rhubarb, &c.

The small-leaved Fuchsias were crossed with *Fuchsia fulgens*, and a hybrid obtained, named *Polyhymnia*, which has a small leaf of the pale colour of *fulgens*, and a long tubular flower with a large corolla also of the same colour as *fulgens* (the pollen of this would never cross with another Fuchsia). By using both Fuchsias as seed-bearers, it was apparent that the habit and form of leaf copied the seed-bearer, and the flower that of the male.

In Pansies the endeavour was to improve the form and size of the flower, and to obtain a more robust constitution, also to raise a Blue Pansy, which was then a desideratum; a Blue Pansy was raised (the first year), and is known by the name of *Imperial Blue*. Twenty-four seedling pansies competed with seven other exhibits at the Royal Botanic Society, and they won the First Prize and the Silver Medal against all the named well-known varieties of the other exhibitors.

With the Cactus, a scarlet was crossed with a white one; there are a number of seedlings, but they have not yet bloomed.

From the Dahlia crosses have resulted the new single Cactus, and other forms with lily-like petals.

The Aquilegia has been crossed with a Clematis, and Clematis-like flowers have been produced.

Centaurea montana crossed with other species has given a few plants with distinct, much larger flowers, and with many more petals, than *Centaurea montana*, which was the seed-bearer. The cross of the Centaurea produced only one or two seeds on the flower-head, instead of the usual sixteen to eighteen; whilst that of the Aquilegia had from six to ten seeds, instead of about one hundred and twenty. Two species of Aquilegia that were crossed, produced a scarlet flower that had nearly a hundred blooms; these were all crossed with pollen from the parent plant, but they did not yield a single seed.

From crossing the Camelia has resulted a double white flower of only two inches in diameter.

From the Primrose have originated that breed known as the Hybrid Polyanthus, which is so well appreciated; whilst from the Oxlip are obtained a number of interesting varieties.

Narcissus poeticus crossed with Empress, Mrs. J. B. M. Camm, and other varieties, has not yet bloomed.

From the Mimulus crosses there is a hybrid with the *Antirrhinum*.

Chrysanthemum atratum crossed with the large Field Daisy have produced several good forms.

The crosses with Red Currants have given some very fine varieties; and the Champagne Rhubarb, impregnated with Victoria, has yielded several varieties that are considered of superior flavour.

The most laborious work, however, has been in raising varieties of Ferns, in order to disprove the assertion that

Ferns could not be crossed. In doing this, many other facts have been discovered, culminating in multiple parentage, the discussion and authentication of which is the object of the present volume.

In giving a history of the marvels of Fern-life and of the new discoveries, I think it will be of interest to Fern cultivators to have connected with this work short memoirs of those who assisted in those discoveries. These labours date back to the time when the crossing of Ferns was discredited, for although described to the British Association as early as 1867, it was not an acknowledged fact until a dozen years ago.

It is only an act of justice to include this help, and in doing so the author cannot forget the great assistance rendered by Professor Morris of Bath in the preparation of this work.

SHIRENEWTON HALL,
February 1895.

CONTENTS

LIST OF PLATES

AND FIFTY-NINE ENGRAVINGS IN THE TEXT.

FERN GROWING

THE experience of fifty-three years' diligent research has made the British Ferns a matter of everyday life with the author. It is impossible to watch each of the changes from the infant to the fully grown frond life of a Fern (not once, but a hundred times, and not of one species, but of nearly all the British species), without observing something new, some peculiarities that seem to upset all our preconceived notions, peculiarities requiring a careful watch, and the repetition over and over again of various experiments. When this has been done for a number of years and with similar results, and not without every precaution being taken in order to thoroughly test the accuracies of these discoveries, at first as regards the possibility of crossing Ferns, which formerly was considered by botanists as an impossibility; then as to the possibility of dividing the prothallus, and of so dividing as to secure the sexes on different divisions; and further, as to the ability of growing any one of these divisions for seven years in the prothalloid condition, and afterwards, at the will of the experimenter, causing it to put forth fronds; and lastly, the ability to cause any three or four varieties to impregnate *at the same time* one of these divisions, and produce varieties showing all their characters blended on one and the same frond—these are facts of such significance that the experimenter is desirous of recording what he has done, and of describing the details.

When once we can find a departure from the normal form, no matter in what species, it is comparatively easy to multiply variations. There are very many more English varieties of the different species than have been hitherto found abroad, and the reason of this seems to be owing to the extensive crossing of varieties that has been going on in the country for a number of years. Two cases may be quoted.

The late Mrs. Grant, of Hillersdon, near Cullompton, in Devonshire, grew Ferns extensively into large specimens, and above her Fernery was a gravel walk on a terrace, which was edged with the usual dwarf box, amongst which were to be found many seedling varieties of the Hart's-tongue Fern that had been naturally crossed and produced distinct forms, all of them originating from plants in her Fernery. Formerly, when raising new varieties by crossing was almost unknown, and scarcely believed in, our best British Fern cultivators only raised Fern spores to obtain duplicates of any desired variety. Amongst those who extensively raised Ferns from spores were the Rev. C. Padley, of Bulwell Hall; Mr. J. Henderson, of Wentworth; Mr. A. Clapham, of Scarborough; Mr. J. M. Barnes, of Milnthorpe; Mr. Stansfield, of Todmorden; Mr. T. Moore, of the Chelsea Botanic Gardens; Mr. W. Willison, of Whitby; Mr. R. Sim, of Foots Cray; Mr. Elworthy, of Nettlecombe; Mr. Joseph Sidebotham, of Bowdon; Mr. C. Glave, of Scarborough; Mr. Riley, of Papplewick; the Rev. F. Mules, of Marwood; and Mr. J. James, of Vauvert: all have now passed away. Each sowed spores separately (except Mr. Clapham, who, after a few years, began to sow several varieties together, in order to economise space); they consequently raised but few variations from the spores sown. These Fern authorities diligently hunted the country for new wild varieties. The author had been raising a large number of forms from crossing before Mr. Clapham would entertain

the idea that there was any good end to be attained; and Mr. Mapplebeck, of Bronddwynant, Dolgelly; Mr. Fox, of Brislington; and Colonel Jones, of Clifton, were the first three to follow the author's example, which they all did with marked success. The late Dr. Lyall, of Newburgh; Messrs. Sang, of Kirkcaldy; Mr. Druery, of Fernholme; Mr. Phillips, of Belfast; Messrs. Stansfield, of Sale; the late Major Cowburn, of Dennel Hill, and others took to multiple sowing a few years ago. There was great promise in what Major Cowburn did; the care, attention, and ability which was so characteristic of him bore a plentiful harvest; but, alas! death suddenly ended this brief but brilliant career. Amongst those who devoted themselves to what has been termed Fern-hunting, *i.e.*, a search in order to discover new wild varieties, none have been so successful as Mr. James Moly, of Langmoor, near Charmouth; Mr. Wills, of Thornscombe; the Rev. Charles Padley, of Bulwell Hall, Nottinghamshire; Mr. James, of Vauvert, Guernsey; Mr. G. B. Wollaston, of Bishops Well, Chislehurst; Mr. J. M. Barnes, of Levens, Milnthorpe; Mr. Clapham, Scarborough; Mr. W. B. Boyd, Midlothian; Mr. G. Whitwell, Kendal; Mr. T. Airey; Mr. and Mrs. Hodgson, of Ulverston; Mr. W. H. Phillips, of Belfast; Mr. R. Lloyd Praeger, of Holywood; and last, though not least, Mr. Forster, of Salford.

In former days there were not gangs of Fern robbers whose everyday business was to practically destroy in any locality what they could find. Twenty-five years ago there were many acres of woods at Hackness, near Scarborough, crowded with *Nephrodium æmulum*, and now it is difficult to find a plant; the Glastonbury district of *Osmunda regalis* is being rapidly destroyed; even the Ben Lawers habitat of the *Holly Fern* has been invaded by these marauders. Ferns are regularly hawked about the streets of our towns by men and even women who are denuding the country of its Ferns.

The occupation of the Fern-hunter who is diligently seeking for abnormal varieties must not be confounded with that of those marauders whose indiscriminate ravage too often results in the annihilating of whole species in the districts they afflict. The former usually finds only solitary plants, and these, if left where found, would after a time perish and the variety become lost; for if they scatter spores in their wild habitat, those of the commoner species choke them out; whilst if removed to a place of safety and carefully tended, offspring are raised, and the new variety is made to adorn many Ferneries. Take as example *Athyrium Filix-fœmina* var. *Victoriæ*, or *Nephrodium paleaceum* var. *cristatum*. Only single plants of each were found, but these have been propagated to such an extent that both are now to be seen in all good collections; but it is not only the saving of these varieties, it is being enabled to cross them, and so raise a large number of interesting intermediate forms, some of which are equally beautiful. The Fern destroyer is annihilating the different species, whilst the man who hunts for new varieties is endeavouring to multiply his choice finds. But names as well as species disappear, and it is necessary to say a few words in explanation.

In "Our Native Ferns" we have *Allosorus crispus*, the name of which has now been changed to *Cryptogramme crispa*. Mr. Thomas Moore, in his "Nature-Printed British Ferns," was half inclined to follow Sir W. J. Hooker, who in his "Species Filicum" adopted *Cryptogramme crispa*, as did Fee in his "Genera Filicum." Moore says, "Perhaps it should be united to *Cryptogramme*," adding, "in habit and aspect they are quite alike." The *Cryptogramme* have the sori to some extent a near copy of that of *Gymnogramme*, whilst in *Allosorus*, Mettenius pointed out, they were punctiform; but they both become laterally confluent, and are then alike. Moore thought that the reflexed marginate indusium which resembles *Pteris*, was overbalanced by the punctiform receptacles; but

Sir W. J. Hooker has thought otherwise, the author thinks correctly.

In "Our Native Ferns," *Lomaria Spicant* was adopted in preference to *Blechnum Spicant*, although Moore, and more recently Druery, have placed this Fern amongst the *Blechnums*. The sori in *Lomaria* are marginal, whilst in *Blechnum* they are inter-marginal; but we have in *Lomaria* contracted fertile fronds, *i.e.*, distinct from the *Blechnum*, which has only one kind of frond. The spreading or prostrate sterile fronds and the erect fertile ones are a marked feature, so much so that it seems preferable to follow Desvaux, Presl, Link, Hooker, Fee, and others in considering our British species *Lomaria*, to following an equal number of botanists who have included it amongst *Blechnum*.

With regard to the *Asplenium Ceterach*, which in "Our Native Ferns" the author had followed Moore in calling *Ceterach officinarum*, even Mr. Moore considered there was a very near relationship to *Asplenium*, though differing in the indusium being obsolete, or only represented by a narrow membranous ridge. In the extra-developed fronds of some of the varieties found in County Clare, there is a very close approach to the indusium of *Asplenium*, and therefore the original name of *Linneus* has now been adopted.

Asplenium Filix-fœmina has been variously placed by our best botanists. Roth, Presl, Fee, Babington, and Bory considered it an *Athyrium;* Bernhardt, Sprengel, R. Brown, Koch, Hooker, Bentham, Kunze, Mettenius, Milde, and Link, an *Asplenium;* Linnæus, Bolton, Weis, Hoffmann, and Bory, a *Polypodium;* Swartz, Schkuhr, Weber, Mohr, Willdenow, and Smith, an *Aspidium*. The sorus of *Asplenium* is linear; in *Athyrium* it is shorter and curved, though varying and approaching that of *Asplenium*. To me the deciduous character of the fronds, their greater size, and more deltoid character are greater differences than that of the sori; but if we

examine a number of plants of other countries, we obtain a gradation that reduces *Athyrium* to a subsection of *Asplenium.*

The English *Polystichums* are also placed as a subsection of *Aspidium*, retaining, with Moore, the three species, *Lonchitis aculeatum*, and *angulare*, in preference to uniting the two latter.

When two species have been crossed, the progeny has invariably been more or less sterile: there is, however, no such thing as complete sterility; when the offspring is confined to one or two, sterility must be more marked than when dealing with species where the offspring would be in thousands. We shall return on a future page to this subject; it is only essential at the present time to state that in crossing *Aspidium angulare* with *Aspidium aculeatum* there is found to be so near an approach to sterility as to warrant us in saying that *A. aculeatum* and *A. angulare* are distinct species. The difference between species and varieties is evidenced by the difficulty of crossing between individuals the first together; whereas with the latter there is no difficulty.

As regards the British *Lastreas* being placed as a subsection of *Nephrodium*, it seems that the peculiarities are too slight to make *Lastrea* and *Nephrodium* into two distinct families; adopting *Lastrea* as a subsection is as far as we can go.

With respect to *N. Filix-mas*, however, there can be no doubt that Wollaston was correct in dividing this Fern into three species; it is as difficult to cross any of these three together as it is with that of any other two species.

Wollaston gave the names of *Filix-mas*, *pseudo-mas*, and *propinqua*, the first deciduous, the second sub-evergreen, and the third a mountain species. Wollaston's names, however, have not been retained, as his *pseudo-mas* is *Nephrodium paleaceum*, *i.e.*, the *Aspidium paleaceum* of Don, whilst his *propinqua* is the *Aspidium abbreviatum* of Poiret; the older names have therefore been adopted. Still our thanks are

due to the keen eye and sound judgment of Wollaston for having shown us their distinctive characters.

These are the only changes that have been made, and in order that no confusion may result to those to whom the old names have become familiar, they have each been headed with the name of the subsection.

In arranging the different varieties in classes, it must be remembered that by wild finds, or by crossing two varieties, we must obtain forms that have characters midway between two classes. As example, taking the Lady Fern, if by crossing the lax *uncum* with *cruciatum* we obtain a variety that is a *cruciate uncum*, or if we cross *corymbiferum* with *cruciatum*, we obtain a *cruciatum* with crested tips to the pinnæ, it will be apparent that in the first example the variety may be with equal propriety placed in the class *cruciatum* or in *uncum*, and in the latter either in *corymbiferum* or *uncum*. It seems, however, more natural that a crested Fern should be classed with crested Ferns, no matter how nearly it copies another class, and that a cruciate Fern should in like manner be placed amongst the cruciate Ferns; and if we do not draw a hard and fast line such Ferns would take an unnecessary amount of time in hunting them in several classes. It is therefore to be understood that all Ferns that are ramose will be placed under *ramosum* (or branched Ferns), all crested Ferns under the section for crested Ferns, all capitate (those having a terminal head broader than the frond) in the *grandiceps* class, and all that are cruciate, even the when characters are those of two or three parents, will be found amongst the *cruciatums*. An exception to this rule will be those that are variegated, for it is obvious that there may be variegated Ferns in any of the classes, and it would be doing away with a very distinctive class if they were otherwise arranged; whilst a second exception, which is almost a contradiction to what has just been said, will be where in the

two characters one is much more pronounced than the other. Multiple parentage very materially increases this difficulty, especially where the three or four characters are almost equally balanced. However, in those cases it will be easier to refer to two or three classes than to search throughout the whole varieties, as would be the case if there were no classification. This classification will, however, have but little to do with the present volume.

Preliminarily it may be mentioned that the author has never (in fifty years' hunting) found two wild fertile varieties exactly alike. Yet the spores from each variety will, if sown alone, reproduce the variety, though not when two varieties are sown thickly together.

Sterile Ferns of the *crispum* form of *Scolopendrium vulgare* are found in numbers together. They are not only found as a cluster of plants mostly almost exactly alike in isolated places of only a few yards in extent, but we have the experience of Colonel Jones, who found twenty-nine near Shirenewton, not at the same time, but in the course of over six years. Again, Major Cowburn discovered six on a wall at Dennel Hill, and each year one or two more till he had found nineteen, and the gardener tells the author that more are now growing on the same wall. Colonel Jones's *crispums* are all broad, and growing more or less horizontally, *i.e.*, the fronds are pendent; but Major Cowburn's are all erect and cut on the margin. At Wollaston, Gloucestershire, a *crispum* was found one hundred years ago, and on the same spot last year Mr. E. Boyle found others. Mr. Baldwyn found a dozen near Tintern, Mr. Bull several near St. Pierre, and each locality has its individuality. None of Colonel Jones's twenty-nine have ever shown any signs of spores. In all these isolated spots there are plenty of common Scolopendriums, but it is doubtful as to how these *crispums* are produced. The Dennel Hill *crispums* are occasionally sparingly *soriferous*, and ad-

vantage has been taken of this to produce a number of crossed varieties. Sterile Ferns will again be referred to.

There are two distinct Fern workers—the hunter after wild finds, and the raiser of seedlings; among the former there are those who care but little for varieties, and devote their energies to the discovery of new habitats of species. The late Professor Hutton Balfour used to say that he was accustomed to treat Ferns as species, that he passed over the varieties without caring to distinguish any varietal forms. The author remembers some twenty years ago ascending Ben Lawers with him, and whilst he was diligently hunting for *Woodsias* he found on his hunting-ground no less than fourteen very distinct varieties, chiefly of the mountain form of *Nephrodium spinulosum*, and that he expressed surprise that he had not recognised these departures from the normal form. A good botanist recognises at once each species without any very close examination, and it is this that causes varieties not to be recognised, unless the form is a very distinct departure from the ordinary type. The discoverers of varieties are therefore a distinct class of observers, who have accustomed themselves to this particular close examination, which has produced many interesting results. Such abnormal varieties as the *crispum* form of the Scolopendrium and the *Cambricum* form of the common Polypody were recognised before the birth of the present century; but many other equally remarkable varieties are modern discoveries, and this is owing to a large increase in the number of those who have devoted themselves to this particular branch of the subject, whose search has been so thorough as to spread over the length and breadth of the land, leaving very few localities unexamined; as an example, Mr. James Moly remarks that some years ago he rarely returned home without treasures, but that now the same localities yield very few new varieties. Some localities are much richer in abnormal forms than

others, and when we come across any of these we are rewarded by the discovery of new varieties. The late Rev. Charles Padley, who devoted many years of his life to this particular branch of inquiry, found as many as fifty good varieties in a single lane, and often a number that resembled each other more or less; but the legion of itinerant Fern merchants was then all but unknown. How different is it at the present time, when you can scarcely ever take a drive without coming across some of them laden with Ferns, which are hawked about the towns. And unfortunately there are so many purchasers that whole districts are denuded of Ferns; and, what is still more unfortunate, a large percentage of these die, leaving vacancies for further consignments.

Amongst those who were most successful in wild finds a few years ago may be mentioned the late Rev. Charles Padley, formerly of Bulwell Hall, in Nottinghamshire, and more recently at Enville (where he died), as clergyman of the parish, and chaplain to the late Earl of Stamford and Warrington; the late Mr. Clapham, of Scarborough; the late Mr. Barnes, of Levens, Milnthorpe, who did so much in the English Lake district; the late Mr. J. James, of Vauvert, in the Channel Islands; the late Mr. Wills, of Thorncombe; the late Colonel A. M. Jones, of Clifton; Mr. G. B. Wollaston, of Bishops Well, Chislehurst; Mr. J. Moly, of Langmoor, Charmouth (who has found nearly all of his treasures in Devon and Dorset); Mr. W. H. Phillips, of Belfast; and a number of those diligent hunters after Ferns who reside in the English Lake district.

Those who have succeeded in raising new varieties from spores are not so numerous; in fact, for some years there was almost no confidence in the idea that Ferns could be crossed like other plants. The author believes that he was the first to set the ball rolling, for the late Professor Arthur Henfrey sent him an account of the discoveries of Professor Nageli,

of Zurich, and of Count Leszazye-Suminski, of Berlin, of the male and female organs of Ferns having been detected on the under-side of the prothallus. This was of course during the prothalloid life of the Fern; for on the discovery by Dr. Lindsay of the prothallium, rather more than a hundred years ago, it was shown that Ferns had two distinct lives, the prothalloid, or caterpillar life, and the fronded, or butterfly life, *i.e.*, the prothallus on being impregnated died away, and the frond life sprang up, grew to maturity, scattered its spores, which germinated into a prothallus, again eventually to produce fronds. The author remembers the idea that at once occurred to him, that it was thus possible, even if difficult, to cross Ferns and produce new varieties. The late Professor Edward Forbes, whom the author was then assisting in the search for British Mollusca, urged him to attempt the experiment; and it is also remembered the disappointment felt when the late Mr. Thomas Moore, of the Chelsea Botanic Gardens, assured him that it was an impossible task; and further, the opinions of Mr. Clapham, Mr. Padley, and others, all agreeing with the assertion of Mr. Moore. Nevertheless Professor Forbes's advice was taken, and experiments commenced. The argument of some was that, assuming it could be done, the operation was so microscopical that it was almost useless for any one to attempt it, and that, although nature might achieve this on one and the same prothallus, it was quite impossible for the male organs from one prothallus to impregnate another.

The author had faith that, if everything was done as regards the first steps in the undertaking, further help might be received in some unknown manner for the rest of the process. If he could not imitate depositing the pollen of flowers on the pistil, nevertheless he might sow spores so thickly as to produce *a crowd of prothalli*, touching each other, or being so near, that minute animal life (like the

impregnation of the flowers by bees) might assist in this impregnation. Spores mixed together have been sown, year after year, since 1851, and a large amount of crossed varieties raised and grown to maturity. Botanists, notwithstanding this, have been slow to acknowledge that these varieties had been produced by crossing. Mr. Moore did acknowledge that he saw the different varieties (the mingling of two forms), but how it had been accomplished he was unable to say. "The *blood* of each was apparent, but nevertheless it has not convinced me," says Mr. Moore, "as regards crossing by impregnation." Mr. Clapham, who had repeated these experiments, and had raised some very distinct varieties, also would not believe in crossing Ferns until he had seen a series of varieties of Lady Ferns, having *Victoriæ* at the one extreme, and *proteum* (a plant that he had found) at the other. On the strength of his new conviction he sowed the spores of the plumose Cornwall, *Polypodium vulgare,* known as *trichomanoides,* with a crested form (*bifido cristatum*), and from these spores he raised a crested form of the variety *trichomanoides.*

Mr. J. E. Mapplebeck, 1866,* Colonel Jones, 1870, Mr. E. F. Fox, 1870, Mr. Craig, 1864, Mr. Moly, 1876, Mr. Barnes, 1867, Mr. Forster, 1876, Mr. Clapham, 1860, Mr. Elworthy, 1873, Dr. Lyall, 1866, Mr. James, 1870, Mr. Hodgson, 1871, Mr. Ivery, 1862, Mr. Stansfield, 1865, Mr. W. H. Phillips, Mr. C. T. Druery, and others (all of whom might be called pupils), commenced raising and crossing spores in the years now recorded, and were eminently successful, notwithstanding which botanists still held aloof. The difficulty of convincing those who receive any departure from preconceived ideas with especial caution has been extremely great. Every argument was met by answers that carried so much of truth in them as to require further proof step by step. One of these argu-

* The author and Mr. Mapplebeck commenced exhibiting seedlings at the Royal Horticultural Society in 1868, Colonel Jones in 1870, and Mr. Druery more recently.

ments referred to previous crosses as otherwise accounting for the variation. At last the crossing of the varieties of Ferns became an acknowledged fact; but, strange to say, our authorities, who could not clearly see that the peculiarities of two English varieties had been combined in one and the same plant, were at length convinced by seeing these peculiarities in a foreign Fern.*

Twenty years ago Colonel Jones, on visiting the author's Fernery, was shown a number of seedling Ferns that had been sown together, in order to obtain a cross of two species, as this was thought would prove an answer to those who still looked upon former evidences with doubt. This caused Colonel Jones to take up the subject, and to repeat the author's experiments in identically the same manner. It was thought, as there had been no previously known variety of a cruciate *Aspidium aculeatum*, that if spores of a cruciate *Aspidium angulare* were sown with a dense-fronded *Aspidium aculeatum*, a cruciate *Aspidium aculeatum* might be the result. This was accomplished, and ought to be an argument far stronger than the mere crossing of two varieties of the same species; but here again the author had to meet the expressed doubt of a number of botanists as to *Aspidium aculeatum* being distinct from *Aspidium angulare* as a species. As mules are more or less sterile, the test of a species ought to be that of sterility. The author crossed the swan goose with the Canadian goose, also the swan goose with the ordinary goose, and the progeny lived many years, and there were eggs laid each year, but no young were ever hatched. The author's father had hybrids between the canary and the linnet, but they never laid fertile eggs. The mule between the ass and the horse is called sterile, but there can scarcely be absolute sterility. It may be twenty thousand to one against the production of offspring

* The late Sir William Jackson Hooker had, however, partly acknowledged to the Rev. M. J. Berkeley that the example he had sent him did look like a hybrid.

from a hybrid, or even greater odds; still, in the case of a Fern where a million spores can be sown, if five or ten seedlings are raised, it is to all intents and purposes a case of sterility, although not absolute sterility. This has been tested by the author over and over again with hybrid Ferns, and certainly not more than one or two plants are raised from fifty thousand spores, whilst the spores from crossed varieties are equally fertile with those of the parent. Now, as a number of other persons also sowed this hybrid over and over again, we may take the experience gained from this one Fern as conclusive. The author sowed unsuccessfully a hundred pans, *i.e.*, ten each year for ten years, and there could not have been less than a million spores. Messrs. Dickson & Co., of Chester, and Messrs. J. R. Pearson, of Chilwell, failed to raise a plant; the late Mr. Carbonell, of Usk, from repeated sowings, raised seven plants; the late Colonel Jones, four; the late Mr. E. F. Fox, two; and the late Mr. Barnes, of Milnthorpe, about thirty plants.* Had these spores been from *crossed varieties* there would have resulted many thousand plants. Do not these experiments prove that *Aspidium aculeatum* and *Aspidium angulare* are distinct species.

Hybrid species are somewhat less rare than is generally supposed. We have the one known as *Nephrodium remotum*, a hybrid between *N. Filix-mas* and *N. spinulosum*, and this has been sown at least a hundred times without producing a single plant, although recently some seedlings were observed on a flower-pan in which this hybrid was growing, and, strange to relate, they eventually proved to be *remotum*. Other hybrids, natural finds, have been discovered, and each of these will eventually be described; but it may be remarked that there is the same difficulty in the raising of spores from them. Although we may have more or less repetition in giving a

* Half these plants, however, are evidently from accidental spores of another Polystichum, which reduces Mr. Barnes's thirty to about thirteen, and perhaps less.

detailed history of the various papers on the crossing of Ferns, still it has been thought desirable to show the gradual advance, as evidenced by the papers read at the British Association, and at the Fern Conference of the Royal Horticultural Society; and also to compile a list of the varieties that have been awarded certificates, pointing out which were wild finds, distinguishing them from raised varieties by footnotes for these records. This is more desirable as we have to refer back many years. Although 1867 was the year in which the author presented his first paper on this subject, he had exhibited numerous varieties at the British Association Floral Fête held in Nottingham in 1866, and had, in fact, raised a large number of varieties as early as 1857, and some even earlier than this.

At the Dundee Meeting of the British Association in 1867,* the author read a paper on "The Abnormal Forms of Ferns," in which were shown the various abnormal forms that species will assume, and said, "It was a singular fact that the varieties of the species have many characters in common, and that a certain law of form extends through all our species, the more usual forms being crested, crisp, imbricated, confluent, ramose, acuminate, narrow, plumose, interrupted, depauperate, and congested, and moreover we have the multiple of this, or the commingling of two or three characters in one frond, such as the narrow-crisped, the multifid-crisped, or the narrow-multifid as examples. In raising duplicates from spores, singular accidental spores have been produced, and a *new method of obtaining varieties detected.*" In speaking of the difference between hybrid species and crossed varieties, it is said in the same paper that "hybrids can be distinguished from crossed varieties, inasmuch as hybrids of species are *unproductive*, whereas the varieties raised from a species can readily be reproduced by spores."

* See page 91, British Association Report, 1867.

Thus in 1867 a printed record first appeared, calling attention to the fact that Ferns could be crossed, although it had been proved, at all events to the author's satisfaction, much earlier, and that during the interval from 1857 the experiments had been repeated over and over again. At that time it was almost universally believed an impossibility, and the author had hesitated to publish the fact, well knowing that it would not be favourably received by those who were considered as best able to form an opinion; and how far there was justification in coming to such conclusion was proved in 1867, when only a solitary botanist could be found who was prepared to look with favour on these results. From that time to the present, hundreds of experiments have been made, in every conceivable direction, with the endeavour to strengthen these views. The experiments speak for themselves, and from them have sprung far more difficult problems which have been to the author's thinking as fully solved.

The next paper of importance was read in Section D of the British Association, at the Meeting at Bath, in 1888, "Abnormal Ferns, Hybrids, and their Parents," * by E. J. Lowe, F.R.S., and Colonel Jones :—"We do not intend by anything said in this paper to ignore the exertions of others in the same field; we only wish to place on record our personal experience, and what we have accomplished by the labour of a number of years."

"More than thirty years ago experiments were commenced, and twenty-one years ago a paper was read by one of us (Mr. Lowe) 'On Hybrid Ferns,' at the Dundee Meeting of the British Association. The subject was at that time in its infancy, and none of the botanists then present, with the exception of the late Professor Balfour, thoroughly believed in these crosses. The next year, 1868, the Rev. M. J. Berkeley sent a paper, on the supposed crossing of two

* Reprinted from "Annals of Botany," Vol. III., No. IX., February 1889.

American species, to the Royal Horticultural Society, and the late Sir William Hooker remarked 'that it was the most probable instance he had yet met with of a real hybrid amongst Ferns.' This was a hybrid between *Camptosorus rhizophyllus* and *Asplenium ebeneum*.

"The late Mr. Clapham, who had given the subject careful investigation for some years, only became convinced by seeing in 1879 the series of examples Mr. Lowe took to the British Association at Sheffield—crosses of varieties of *Asplenium*, section *Athyrium*, from mixed spores of *Victoriæ* and *proteum*.*

"Afterwards, about fifteen years ago, endeavours were made by one of us (Mr. Lowe) to cross *Aspidium aculeatum* with *Aspidium angulare*, and when the seedlings had become mature (seven years afterwards) it was apparent, at all events to the experimenter, that this cross had been accomplished, but in only five examples out of 1000 seedlings. The object was to obtain a narrow cruciate variety of *Aspidium aculeatum*, a copy in *Aspidium aculeatum* of the narrow cruciate variety *Wakelyanum* of *Aspidium angulare*, for as yet this was a desideratum. *Aspidium angulare*, variety *Wakelyanum* (Fig. 1),† was sown together with a dense-fronded variety of *Aspidium aculeatum*, known as *densum* (Fig. 2), the result being a hybrid cruciate *A. aculeatum* (Fig. 3). In 1884 specimens of this hybrid and a short paper were sent to the Linnean Society, but this was not sufficient to remove the doubts of botanists; a year later, however, a letter from Sir Joseph Hooker stated that the crossing of Ferns was then an acknowledged fact.‡ This hybrid (Fig 3) and its parents, together with some of the offspring of the hybrid, were last year exhibited at the Bath Floral Fête, amongst the specimens

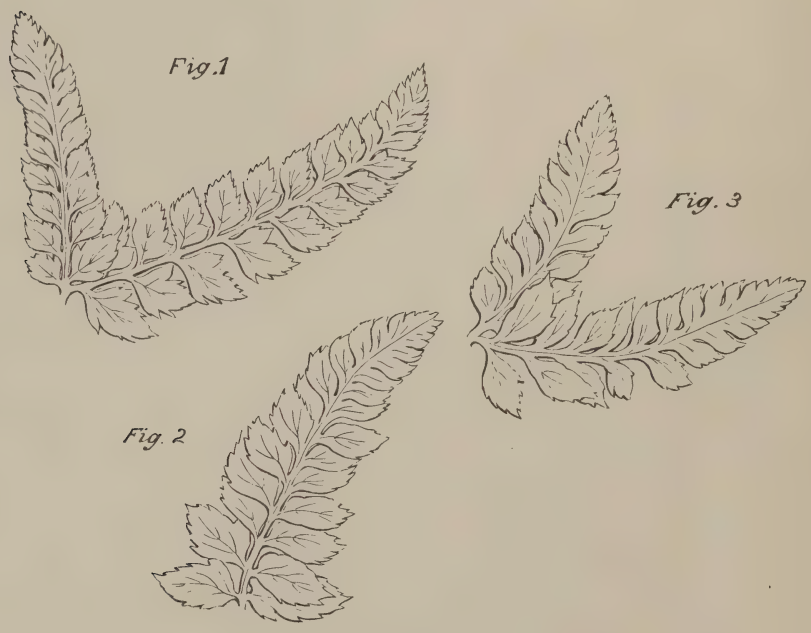
* *Proteum* has only part of the fronds cruciate; in *proteoides* all are cruciate.

† Figures 1, 2, and 3 are pinnæ from the centre of the fronds.

‡ Eighteen years after the Dundee Meeting of the British Association.

of botanical interest, and it was awarded a first-class certificate.

"Both of us have had great experience in the crossing of Ferns, one of us (Colonel Jones) starting twenty years later than the other, and our results coincide. Instances of crossing have now accumulated to such an extent as to preclude the possibility of any further doubt on the subject. To produce the results, however, great care is necessary



that the germination of the spores are very general and also simultaneous. The clear proof of the reality of the crossing of varieties lies in the fact of the production of plants either bearing a character intermediate between those of the plants sown, or combining their characters.

"A remarkable fact in connection with the crosses is the frequent transference of the character of one variety to another; this even applies to variegation. It will be seen in

the example of the cruciate hybrid of *Aspidium aculeatum* that it is a marked copy of the cruciate form of *A. angulare*, one of the parents selected with the object of obtaining a

cruciate *P. aculeatum*. Instead of the usual gradual process, the form was obtained at once.* This applies equally in the case of the polydactylous forms of *A. angulare* (see Figs.

* A further inference that a number of sperms are employed in the impregnation of a cell.

4, 5, and 6, page 19),* and in the variegated forms of *Scolopendrium vulgare.*

"As examples we have selected experiments made with varieties of Asplenium, section *Athyrium*, and *Scolopendrium* from Mr. Lowe's series, and some made with varieties of Aspidium, section *Polystichum*, from Colonel Jones's series. We might have given several hundred examples, but a few of each is ample illustration.

"*Example* 1. ATHYRIUM.

"The following varieties were sown together:—*Victoriæ, multifidum, Jonesii, Craigii, uncum, Harrisæ, cruciatum proteoides, tortile, reflexum, laciniatum*, and *grammicon.*

"The result has been several hundred intermediate forms, some very interesting.

"*Example* 2. SCOLOPENDRIUM.

"In this experiment the varieties were *crispum* (rarely fertile), *Victoriæ, muricatum, marginatum, undulatum, digitatum, ramo-cristatum, laceratum*, and a variegated *crispum.*

"The result has been various intermediate forms, a number of which are variegated; for instance, the variegation in the *crispum* has passed into a crested form, the colour as well as the shape being altered.

"*Example* 3. POLYSTICHUM.

"The attempt was made to transfer the polydactylous character of certain forms of *P. angulare* to other forms of the same species which preserved the normal outline and distinct individuality but were not polydactylous.

* Fig. 4, var. *polydactylum*, crossed with Fig. 5, var. *pulcherrimum*, Fig. 6, a crested seedling showing the polydactylous character combined with pulcherrimum.

"The forms used were Mr. Padley's polydactylous form from the Vale of Avoca, and Colonel Jones's Hampshire form. The polydactylous character has now been successfully transferred to the forms known as *decompositum*, *acutilobum*, *divisilobum*, *frondosum*, *alatum*, *lineare*, *congestum*, Padley's *variegatum*, and others. The polydactylous character of *P. angulare* has also been transferred to *P. aculeatum*.

"There are four clearly established cases in which the characters of distinct forms of *P. angulare* have been transferred to *P. aculeatum*. Hitherto the varieties of *P. aculeatum* have been very few, so that now a new field for exertion is open, the results of which it is difficult to over-estimate, for the robust constitution of *P. aculeatum* enables it to thrive in climates in which *P. angulare* would soon perish.

"The interest in the varieties of British Ferns ought to increase, now the crossing of varieties has become an acknowledged fact, alike on account of the extreme beauty of many of the crosses already effected, and also because, however beautiful crosses already obtained are, it may be confidently asserted that they are nothing to what will be accomplished when exhaustive experiments, guided by tasteful and judicious selection, shall have been made. Though much will depend on selection, there will always be enough left to the element of chance to keep up the interest. We may liken the prospect of endless combinations to the combinations in bell-ringing, and we learn that the changes in the ringing of twelve bells amount to forty millions. We can scarcely conceive of the immense field of inquiry that is opened up in these investigations. The number of forms to be obtained is past conception, and as the discovery of one truth is the stepping-stone to the discovery of even greater truths, so every new form that is raised enables the raiser or those following in his footsteps to produce countless other combinations."

Botanists had been protesting over and over again against the use of descriptive and compound Latin names that were so generally adopted by the raisers and discoverers of varieties of British Ferns, so at length it was determined to hold a Fern conference and a Fern show at the Chiswick Gardens of the Royal Horticultural Society, and as from this seems to date the turning-point to a more healthy state of things, it is desirable that it should be placed on record with full details both as regards the show and the congress. In the arrangements of the Royal Horticultural Society for 1890, as published in their "Transactions," we find :—

ARRANGEMENTS FOR THE FERN CONFERENCE.

The Conference will commence on Wednesday, July 23rd, at 2 P.M., J. G. BAKER, Esq., F.R.S., President of the Conference, in the Chair.

Papers will be read as follow :—

"The Systematic Relations of Ferns," by Professor BOWER, F.R.S.
"The Cultivation of Exotic Ferns," by Mr. W. H. GOWER, F.R.H.S.
"Hybrid Ferns," by Mr. E. J. LOWE, F.R.S., F.R.H.S.
"Plumose British Ferns," by Mr. C. T. DRUERY, F.L.S., F.R.H.S.
"Hardy Ferns and their Cultivation," by Mr. J. BIRKENHEAD, F.R.H.S.

The following ladies and gentlemen have been requested to act as a General Committee :—Mr. J. G. BAKER, F.R.S. ; Professor BOWER, F.R.S. ; Mr. W. H. GOWER, F.R.H.S. ; Mr. E. J. LOWE, F.R.S. ; Mr. C. T. DRUERY, F.L.S. ; Mr. J. BIRKENHEAD, F.R.H.S. ; Dr. F. W. STANSFIELD ; Mr. R. Ll. PRAEGER, B.E. ; Mr. E. F. FOX ; Mr. JAMES MOLY ; Sir E. G. LODER, Bart., F.R.H.S. ; Major T. B. COWBURN, F.R.H.S. ; Mrs. C. COOPER ; Miss H. J. KITSON ; Mr. R. IRWIN LYNCH, A.L.S. ; Mr. E. J. WALKER ; Mr. W. B. LATHAM, F.R.H.S. ; Mr. P. NEILL FRASER, F.R.S.E., F.R.H.S. ; Mr. W. FORSTER ; Mr. J. LORAINE BALDWIN ; Mr. J. E. MAPPLEBECK, F.L.S ; Mr. JAMES O'BRIEN, F.R.H.S. ; Mr. H. B. MAY, F.R.H.S. ; Colonel BEDDOME, F.L.S. ; Mr. J. H. FITT.

ROYAL HORTICULTURAL SOCIETY, July 22nd, 1890, EXHIBITION OF FERNS.

SCHEDULE.

For the better examination and comparison of the Plants, it is particularly requested that Exhibitors will arrange their Collections in the following groups:—

BRITISH FERNS.

CLASS 1.*

Group 1.—Adiantum Capillus-Veneris (Maidenhair) and varieties.
„ 2.—Aspleniums (Spleenworts) and varieties.
„ 3.—Athyrium Filix-fœmina (Lady Fern) and varieties.
„ 4.—Lastræa Filix-mas (the Male Fern) and varieties.
„ 5.—Polypodium vulgare and varieties.
„ 6.—Polystichum aculeatum and angulare (the Shield Fern) and varieties.
„ 7.—Scolopendrium vulgare (the Hart's-tongue) and varieties.
„ 8.—Blechnum Spicant (the Hard Fern) and varieties.
„ 9.—Hymenophyllum and Trichomanes radicans (Filmy Ferns, Tunbridge Fern, Killarney Fern) and varieties.
„ 10.—Other British Ferns, Allosorus, Ceterach, Cystopteris, Osmunda, Lastrea (except Filix-mas), Polypodium (except vulgare), Pteris, &c.

PRIZES.

In addition to any Awards which the Council of the Society may themselves see fit to make at the time to any Exhibitors in the foregoing Classes, the following Prizes have been placed at their disposal:—

OPEN TO AMATEURS ONLY.

CLASS A.—A Silver Challenge Cup, presented to the Society by N. N. SHERWOOD, ESQ., F.R.H.S., for the best Collection of Hardy Ferns and their Varieties. Cultivation and beauty of form to be taken into consideration even more than the mere number of varieties shown. The plants must have been in the Exhibitor's possession before January 1st, 1890.

If won by the same Exhibitor two years in succession, to become the property of the winner.

(B.—A Silver Cup was also offered for "Hardy Filmy Ferns," but none were exhibited, probably owing to the risk of injury to the plants.)

* Nomenclature as used by the Royal Horticultural Society.

The following are extracts from a paper read at the Fern Conference* of the Royal Horticultural Society at the "Fern Show" in 1890,† "Hybrid Ferns and Crossed Varieties," by Mr. E. J. Lowe, F.R.S. :—"A paper embracing all that is of interest in so important a subject as hybrid species and crossed varieties would occupy more time than could be devoted to it this afternoon. An outline is all that can be attempted.

"It is comparatively a new branch of inquiry, and fresh facts are constantly cropping up.

"Although the crossing of Ferns has only been recently acknowledged, nevertheless my own investigations, experiments, and may it be added successes, commenced many years ago, dating even to the middle of the century. It has therefore been thought that a brief history of my own work may not be unacceptable.

"In the first place, let me explain that a hybrid Fern is the offspring of two so-called species—as example, between *Asplenium marinum* and *Asplenium lanceolatum;* whilst the offspring of two varieties of the same species is called a cross.

"Forty-six years ago a German botanist discovered the reproductive organs of Ferns; before this we only knew that sori containing numbers of spores were formed on the under-side of the fronds, and that these varied in shape and position in different genera. Spores when they fell to the ground under favourable circumstances were known to germinate, at first appearing as mere points, and in course of time expanding and somewhat imitating the appearance of liverwort. Eventually a tiny frondlet would show itself, to be followed by others, larger and larger, and more and more developed, until a mature plant resulted.

* Owing to Mr. Baker's absence through illness the question of the proper nomenclature for Fern varieties was not discussed.

† [Reprinted from the "Journal of the Royal Horticultural Society," Part III., Vol. XII.]

"It was on the under-side, during its prothalloid or liverwort life, that the reproductive organs were discovered. Thus there is a dual existence: the spore producing the prothallus, and the impregnated prothallus the frond-life, which in its turn produces the spore to repeat the process. This discovery was made in the year 1844. The late Professor Henfrey gave the details in 1851, and the author remembers at once pointing out to the late Professor Edward Forbes that it would not be difficult to cross Ferns, and by his persuasion commenced experiments. At that time there were but few well-marked varieties, but in the next ten years many more were discovered by Padley, Barnes, Clapham, Stansfield, Sim, and others.

"My first mixed spores were sown in 1855, but the crop of seedlings were nearly all normal; whilst at the present time it is difficult for me to raise a normal form: one or two marked varieties used to be the reward, now they can be counted by hundreds. We have eventually got so far away from the original species that the primitive characters seem to be lost.

"When living in Nottinghamshire there were no wild Ferns near my residence, but favourable situations were in course of time crowded with varieties scattered by the winds from the Fernery. The author could by the year 1875 find more distinct forms within a mile radius than could be collected by months' diligent search in a wild Fern district. This has been repeated at Shirenewton; for, although the Ferns have not been there ten years, the spores have sown themselves in all directions.

"A change of circumstances with a large number of varieties of *Scolopendrium vulgare—i.e.*, planted where the surroundings were not favourable—caused all of them to return to the normal form of the species. Under pot culture the author has never found varieties to degenerate; better

soil, a more favourable situation, and greater attention are sufficient reasons.

"At the Dundee Meeting of the British Association in 1867, it was pointed out that a certain law of form in the varieties of Ferns seemed to be common to all species—crested, branched, revolved, truncated, tortuose, brachiate, plumose, cruciate, linear, or depauperate, in both fronds, pinnæ and pinnules—and the manner of these changes are common to all the species, and even the multiple of these, the combination of several characters, such as the linear-crested or cruciate-crested. In course of time we may produce plants having many of these forms combined on the same frond.

"Again, spores gathered from an abnormal portion of a frond can reproduce this abnormality, whilst spores from a normal portion of the same frond can produce normal plants. Also, if plants are raised from varieties for several generations, it is almost impossible to obtain the original normal forms.

"The spores from crossed varieties are quite as proliferous as that of the normal form, whilst hybrids—*i.e.*, crossed species—are all but sterile. There appears to be no absolute sterility. Take the hybrids that were raised between the Aspidiums *aculeatum* and *angulare*. A hundred pans of spores that were sown did not produce a single plant. Mr. Carbonell, however, raised nine, and Mr. Barnes thirty plants,* all of which differ from the parents and hybrids, the grandchildren being mostly congested in growth. With regard to *Nephrodium remotum*, a hybrid between *spinulosum* and *Filix-mas*, repeated sowing of spores for more than ten years did not produce a single plant, though by accident Dr. Stansfield once succeeded.

"At the British Association Meeting in 1870, the author gave the following additional results :—

* Half of Mr. Barnes's seedlings had nothing to do with the spores sown.

"Spores from a normal frond produced only normal Ferns.

"Equal proportions of spores from a normal and from an abnormal frond produced ninety per cent. of abnormal forms.

"Spores sown *in separate pans* from abnormal fronds *produced plants like the variety* from which they were gathered.

"Spores from a dozen varieties mixed together produced many new varieties, and the more remarkable the varieties selected, the more extraordinary were the results.

"Further experiments on hybrid Ferns and crossed varieties were reported to the British Association in 1865, 1867, 1870, and 1888, but the late Professor Hutton Balfour was the only botanist who would allow that a cross had been obtained up to the year 1885; indeed it was difficult even to convince such experienced Fern authorities as the late Thomas Moore and Abraham Clapham, although the latter in 1879 acknowledged he was satisfied, and, what was more to the point, commenced experiments and raised some beautiful forms of *Polypodium vulgare*. A large number of fine varieties have been raised by crossing, and for these we are especially indebted to the late Colonel Jones, Mr. Mapplebeck, Mr. Barnes, Mr. Clapham, Messrs. Stansfield, and Mr. E. F. Fox, for many of these plants, and also for numerous wild finds; for the latter we must also acknowledge the successful labours of Messrs. Padley, Elworthy, Hodgson, Moly, Lyall, James, Wollaston, Phillips, Mapplebeck, Airey, Whitwell, Forster, O'Kelly, Fraser, Praeger, Cooper, Druery, Patey, Wilson, Bolton, Cowburn, and others. Far more varieties are raised from spores than are found wild; but we get new blood, new forms, and consequently increased vigour from the latter, that adds to the importance of wild finds.

"Some Ferns have young plants growing on their fronds,

and these are termed 'bulbils,' yet these young plants are not invariably like the parent. In 1865 bulbils from *Scolopendrium Wardii* produced strong-growing conglomerate forms, and bulbils on the crested *Osmunda regalis* yielded a dwarf *grandiceps*, with a more spreading root; this plant is now twenty-five years old. Bulbils from *Scolopendrium Kelwayi* have produced a more diminutive form; and others from Colonel Jones's polydactylous *divisilobum* of *Aspidium angulare*, plants that are not polydactylous.* Ferns that are not usually bulbiferous occasionally put on this character. Miss Bellairs sent me the Axminster plumose Lady Fern, having the fronds crowded with young plants.

"There is yet another means of propagation which has been discovered by Mr. Druery in the sterile Lady Fern known as *Clarissima*. This is in reality the formation of prothalli on the frond without the medium of the spore; when these touch the ground they strike root and produce fronds. More than twenty years ago Mr. Clapham showed me an *Adiantum Capillus-Veneris*, having fronds touching the ground, producing a crop of young plants, and this might have been a case of apospory. Plants, however, raised by this means are also liable to sport. Colonel Jones had several more or less revolved, one furcate, and another not unlike Elworthy's *subplumosum*.

"As soon as the discovery of the reproductive organs was known, it occurred to me that the character of the frond must depend upon whether impregnation took place from the same prothallus or from one of a different Fern. This determined me, in making my first experiments, to mix the spores of two varieties of the Hart's-tongue, and as another experiment, two varieties of the Lady Fern. In one of these

* The beautiful plumose varieties of *Aspidium angulare*, *Baldwini*, and *imbricatum*, which received certificates at the Conference, were from bulbils produced on the var. *densum* of *divisilobum-plumosum*.

experiments with the latter species strong roots were formed, and on examination three separate plants were seen. Major Cowburn and myself both saw excrescences on different plants of a branching *Scolopendrium*, and afterwards roots on the upper surface of the fronds near the base of the stripes, and both of these examples threw out frondlets before being pegged down; eventually they were made to touch the soil, and soon produced independent plants; but if there had been prothalli, it had become obliterated before we had noticed the excrescences. The seedlings from these convinced me that a cross had been obtained between the two varieties.

"The next experiment was with spores from the varieties of the Lady Fern known as *Victoriæ* and *proteoides*. These seedlings showed a series of variations, having *Victoriæ* at the one extreme and *proteoides* at the other.

"A further experiment was the mixing together the spores of half-a-dozen varieties of the Lady Fern, and, as another trial, half-a-dozen varieties of the Hart's-tongue. This brought out a new fact—there were seedlings that showed the characters of three and even four varieties on a single frond, so that male organs from several varieties had assisted in this impregnation. The microscopic character of these organs was a difficulty to be overcome in crossing Ferns, and the only way to overcome this seemed to be sowing the Fern spores thickly together, trusting to their close proximity to enable two or more varieties to be self-crossed. The antheridia (or male organs) having been noticed to move about with activity in the moisture on the surface of the prothallus, it was thought possible for them to come in contact with the archegonia on another prothallus, and thus fertilisation would take place on a different plant; and this has been accomplished.

"The above idea was more recently considerably strengthened from the remarks of my friend Dr. Hudson, F.R.S.,

a great authority on microscopic animal life. He showed that it required a crowd of male organs to effect impregnation amongst certain microscopic animals; and to test if this extended to Ferns, further experiments were made—*i.e.*, sowing together in equal quantities spores from a crested and from a normal form of *Nephrodium paleaceum*—in order to ascertain the proportion of crested to non-crested seedlings. These plants are another proof, for there is not a single plant that is not crested more or less. However, the author had in reality proved this previously when spores from four varieties sown together produced seedlings having all their characters on one frond.

"Another experiment with the Hart's-tongue is also of peculiar interest. An undulate form, a spiral form, a rugose form, and a tasselled form were sown together, and amongst the seedlings there are plants that exhibit all these characteristics.*

"Ferns that the author is now sowing spores from have a long pedigree—some date back more than thirty years, at least a dozen generations, and the seedlings from these plants are all abnormal. Over and over again the author has had batches of seedlings without producing a single common normal form. It is quite true that these may revert under adverse circumstances to the original form, *and keep normal under those conditions.* Nevertheless a more generous treatment and a more suitable situation will, in the course of time, restore them to their original varietal characters. As early as 1844 the author divided *Polypodium Cambricum* and *Scolopendrium crispum*, growing the one half in large flower-pots, and planting out the other halves in exposed situations in a soil mainly composed of new red sandstone. In the course of a few years both these varieties that were planted out had returned to the

* Further information with illustrations will be found in another part of this work.

normal state, yet divisions taken from them, in time again became true *Cambricum* and *crispum*. This was also well seen in the *Scolopendriums* that were moved from Nottinghamshire to Shirenewton Hall in 1881. They were planted in an unsuitable situation, and although there were nearly five hundred distinct varieties, in three or four years they were all common Hart's-tongues. In 1886 and 1887 they were again transplanted, and have gradually returned to their original varietal forms.

"In 1876 an attempt was made to cross two species; and as there were no known cruciate forms of *Aspidium aculeatum*, it was determined to try to produce one, for, if successful, this would be a satisfactory proof. The varieties selected were *Aspidium angulare* var. *Wakelyanum*, and *Aspidium aculeatum* var. *densum*, the former being cruciate.* Out of a batch of several thousand seedlings there were five plants unmistakably cruciate *aculeatums*, and also a close copy of the cruciate *angulare*. For six years these five plants were normal *aculeatums*, but on the seventh they assumed the narrow cruciate form. In 1884 Mr. E. F. Fox and the late Colonel Jones repeated the experiment successfully. At the same time they both endeavoured to add the polydactylous character to different varieties of *Aspidium angulare*, and succeeded; the most marked of Mr. Fox's seedlings being polydactylous *congestum* forms; and those of Colonel Jones various polydactylous varieties of *divisilobum* and *lineare*, and a variegated *polydactylum* of Padley's variegated *angulare*. The author had previously produced similar polydactylous forms in the Lady Fern. The endeavour to produce various golden Hart's-tongues from using spores of different varieties mixed with those of a golden form, resulted in variegated seedlings which speak for themselves.

* Alluded to with illustrations in a paper read at the British Association in 1888. See page 16.

"One of his more recent experiments was the endeavour to ascertain whether more than one plant could be produced from a single prothallus. It had been noticed over and over again that in trying to separate seedlings into single plants, it often occurred that some were so closely connected that it required great skill in separating them. When these grew to maturity, most of them were seen to resemble each other, and probably had sprung from one prothallus, and this was well seen, more especially in three plants of a very distinct variety copying each other.

"Four years ago he transplanted spores very thinly so as to allow them room to expand. When these prothalli were fully grown, a number were cut with a sharp knife into two, three, and four pieces, and replanted; and those simply cut into two produced two plants, but when divided into four they have not produced fronds; they have increased in size, and though it is more than two years since they were divided, are yet without fronds.* It seems certain that the male organs must be on one portion and the females on another; hence the absence of fronds.

"Increased or diminished development in fronds, pinnæ, or pinnules, in endless directions, will eventually add enormously to the varieties cultivated. The energies are often expended in certain directions, a large capitate head may be at the expense of the tassels of the pinnæ, or large tasselled pinnæ at the expense of the capitate head. A well-developed plumose form is more or less sterile: the energy is directed in subdivision, and in consequence the texture is thinner, and there does not appear to be sufficient strength left to produce spores. On rare occasions there is a thickening in this texture on parts of the frond, and there sori are formed.†

* Now more than six years ago, and three of the prothalli are as yet alive but still without fronds.

† The *A. angulare* var. *Baldwini* has this year become sparingly soriferous; the sori are few in number, almost solitary, and there is no indusium.

In the case of the plumose form of the Hart's-tongue known as *crispum*, occasionally a number of plants, all sterile, are found in close proximity; the late Colonel Jones found twenty-nine near Shirenewton, and Major Cowburn has found nineteen at Dennel Hill. Marvellous wild finds are usually solitary examples. The *Nephrodium paleaceum* var. *cristatum* found in the west of England was a single specimen, and no second example has been discovered; yet a somewhat similar form has more recently, however, been found in North Wales, the two differing in the one being *flat*-crested and the other *bunch*-crested.

"An increase in the strength of a plumose form would thicken the texture of the frond, and enable it to bear spores. Experiments have been tried on flowering plants as well as on Ferns, in the hope of procuring this strengthening result. Taking into consideration that a vast number of antheridia may be requisite to fertilise a Fern, and a shower of pollen to impregnate a flower, the single dahlia was selected as a flowering example, and a capitate form of *Aspidium angulare* as that of the Fern to be experimented upon. As it was wished to use six times as much pollen of a white dahlia as that of a pink one, six small brushes were filled with the pollen of a white flower, and one from that which was pink, the whole being collected on a larger brush and then repeatedly applied to a white flower. The result in the seedlings was eighty-seven per cent. of white flowers; whilst equal parts of white and pink pollen only gave forty-four per cent. of white flowers. The second experiment with *Aspidium angulare*, in order to increase size as well as greater development, could only be done by using mixed spores in certain proportions—*i.e.*, six times the number of spores from the largest crested varieties to one of a variety of larger growth, if sown together, it was thought might be the means of increasing the vigour of the plants, and thus produce a Fern

having a larger size and a greater crest: these plants give great promise of a successful issue, though they are as yet only infants.* Strength added in this way might develop a tri-pinnate frond, so that the lobes of the pinnules should even become stalked, crested, and more divided.

"Investigations such as these are not confined to Ferns; they extend to flowering plants, and a great future is before the student who prosecutes these inquiries. Those who give themselves up to scientific investigations cannot avoid receiving adverse expressions from unbelievers; but doubt *may* change to belief, for sooner or later truth will assert itself. The reasoning which at first seemed cloudy and obscure, may, by the multiplication of a chain of evidence, clear away these clouds, and then the sun, the emblem of truth, will shine in all his glory."

In the discussion on this paper, Dr. D. H. Scott, F.R.S., of the Experimental Laboratory of the Royal Gardens, Kew, said—

"The most surprising statements in Mr. Lowe's interesting paper related to the combination of the characters of several varieties in a single individual in cases where the spores of the varieties in question had been sown together. If the results were really due to multiple hybridisation, it would involve the fertilisation of an ovum by several spermatozoids, each contributing somewhat of its own character to the offspring. This supposition contradicted all that was directly known as to fertilisation in Ferns, in which it had always been found that only a single spermatozoid fused with the ovum; instances of multiple fertilisation in plants were rare. It had been stated that in *fucus* more than one spermatozoid united with the ovum, but recent observations had rendered this very doubtful. Mr. Lowe's explanations of the facts could hardly be accepted by botanists until direct

* More mature now, and the plants strong and largely capitate.

microscopic observations had established the possibility of multiple fertilisation in Ferns." *

Professor Bower, F.R.S., said "this inquiry had now arrived at the stage when it might be put to a vigorous test. Perhaps the best way would be to cultivate certain 'prothallia,' and then to actually follow the whole process of development through, under the microscope. The next step would be to proceed in the same way as with fungi. He thought the views put before the conference that afternoon would make any man take the subject in hand to investigate."

Dr. Stansfield, of Reading, said "he had experimented in the same way as Mr. Lowe with spores of the Axminster variety (of the Lady Fern), with the result that a multiple character was produced. The spores were sown together, and great variety was shown in the progeny. Not only was cresting developed in the pinnules, but instead of a flat crest a round one was obtained. Another result different

* There are so many difficulties to be surmounted in a microscopic examination, that it may be years (if ever) before the microscope discloses multiple parentage in Ferns. The author has tried it himself and failed. One of the difficulties is the absolute necessity of thick sowing, for when prothalli do not touch each other we cannot obtain a cross; and if we grew them separately, and then brought two or three others, and planted them so that they overlapped, the facilities would not be increased, as there must still be the difficulty of a clear view; and the organs of generation might not be in a proper condition at the same time.

Then again, so few are the instances of multiple impregnation in comparison to the number of spores sown, that a thousand distinct microscopical investigations might not yield a single example. It is no doubt desirable to repeat the attempt, as this might be observed; but a negative result could not contradict it. If, in addition to more than one spore entering a single cell, and more than one cell on a prothallus being impregnated, we have the assimilation of all the cells on one and the same prothallus to contend with, the investigation seems hopeless. The fortunate microscopist who shall, at the right time, succeed in a thorough examination of an impregnated Fern ovum, or Fern ova, will probably see *not* a single spermatozoid, but an ovum bristling with the tails of a crowd of these tadpole-like organs (as have been seen in microscopical animal life), and thus be able to explain the usefulness of large numbers of spermatozoids; but not only this, he will have established a position that but few could ever hope to attain.

from Mr. Druery's was from sowing *plumosum elegans* (of the Lady Fern). It did not result in any 'cresting,' but in the development of the cutting of the pinnules."

Extracts from a Paper read at the British Association Meeting at Cardiff in 1891, *by the Author.**

Facts regarding Prothalli and the Propagation of Ferns.

"Occasionally in a batch of seedling Ferns there will occur several plants of some strangely marked variety identical in their characters, and growing so closely together that it is difficult to separate them. The author has long suspected these were produced on the same prothallus; indeed this seemed evident in four instances of remarkable seedling *Athyriums*, yet the development was too far advanced for absolute certainty. To examine this carefully, a number of *Scolopendriums* were planted in the prothallus state, and on the young fronds appearing, two were noticed identical in character and unusual in form, which when examined were found to have their origin in one well-developed prothallus. With a penknife it was possible to divide the prothallus so as to secure the two plants, which were planted in a pan and have not since been disturbed.

"Prothalli were then planted from a pan of mixed muricate and undulate *Scolopendriums*, and these were divided before the formation of fronds into two equal parts; in some examples the two plants resulting were alike, in others they differed, but showed their muricate and undulate origin.

"The next experiment was dividing the prothallus into four equal parts. This was done in January 1888. Every division grew and spread in a more bush-like manner than is the

* See "Report of British Association, 1891."

case with undivided prothalli, but up to July 1890 there was no sign of any frond. It appeared evident that the male and female organs of generation were on separate divisions. To test this, in May 1890 another prothallus was planted in close proximity to one of these, in fact made to actually intermingle, and in August fronds appeared. The other divisions, except four, were similarly treated, and all have now produced fronds. The spores had been sown on August 1887, and divided on January 12th, 1888, so that the prothallus exhibited has been in this condition four years. The usual time from prothallus to frond being only a few months.

"In an interesting example of the Lady Fern (alluded to in the next paper), a prothallus produced three plants exactly alike and having two kinds of fronds. It was from a mixture of eight varieties, and these show the parentage of six, and now and then seven. They have the lax pinnæ of *uncum*, the cruciate pinnæ of *Victoriæ*, the projected pinnæ of *projectum*, the lunulate pinnules of *Frizelliæ*, the cruciate pinnules of *crucipinnulum*, the truncate terminals of *truncatum*, and occasionally the cresting of *multifidum*. This Fern has reproduced six and occasionally seven characters. According to the doctrine of probability, it is 720 to 1 against the production of six varieties on the same plant, and 5040 against seven.

"Turning to other means of reproduction, experiments are required in order to ascertain why the bulbils that form on some fronds do not always produce plants like the parents, and why it is possible to transfer the bulb-bearing character to other varieties. *Scolopendrium densum* often produces much more coarse and less-divided Ferns than itself. *A. angulare plumoso-divisilobum* var. *densum* has produced two plants from its bulbils that are strikingly distinct from the parent and each other; one is densely imbricate and procumbent like the parent; whilst the other is as finely divided as *Todea superba*, and is erect in habit. Again aposporous plants,

that is, those raised from the prothalli direct without the intermediate spore, also vary. (An aposporous plant of *Clarissima** of the Lady Fern shows this.)

"Even plants raised from the base of the stipes of plumose *Scolopendriums* have produced marginal belts."

Extracts from a second Paper read at the British Association Meeting at Cardiff in 1891, *by the Author.*

On Ferns and their Multiple Parents.

"Colonel Jones and myself read a joint-paper on abnormal Ferns at the Bath Meeting of the British Association, which is printed in full, with illustrations, in the third volume of the 'Annals of Botany.' The present paper is a report on further experiments, and on the surprising discoveries that have resulted.

"Since 1887 other hybrids have been obtained, and although these hybrids are more or less sterile, a few plants (grandchildren of the original parents) have been raised, and they differ so much from the parent that nearly all resemblance has disappeared. What will be the characters of the great-grandchildren is now in course of proof.† It is very different in the case of the offspring of crossed varieties: they are copiously fertile, and when sown alone reproduce their varietal form. Not only have certain forms been imparted to other Ferns, but even variegation, notably so in the Shield Fern and the Hart's-tongue. In the latter, spores from a normal but variegated form were sown thickly with a plumose (or crispum form) and a branching form, and their offspring have become variegated. By sowing a muricate and a plumose Hart's-tongue together, muricate-plumose varieties have

* Named after Clara, Colonel Jones's wife—not a Latin word.

† 1893. Not sterile, less congested than the grandchildren, some even robust.

also resulted. For illustrating multiple parentage, the Hart's-tongue has been selected, as the simple, strap-shaped fronds are best able to show the various departures from the normal form.

"In repeating the experiments of mixed spores, the varieties in each case have been limited to three or four, so that the resultant changes could be more narrowly investigated. Distinct mixtures were sown in 1887, 1888, 1889, and 1890, and the results in all the experiments establish the fact that the antheridia of more than one variety have assisted in the impregnation. The varieties had conspicuously distinct characters, and in an example of 1888 the spores were gathered from a dwarf spiral form, a muricate or warty form, an undulate, and a ramose one; more exactly speaking, the varieties were *spirale*, *undulatum*, *muricatum*, and *keratoides*. The parents are exhibited as well as three of their children, the latter having the names of *quadriparens*, *Darwiniana*, and *echinatum*. They unmistakably show on each plant the characters of the whole of these parents. In the hundreds of these seedlings, as might be expected, the majority show only the characters of two parents, in a less though considerable number the characters of three, whilst only a small number exhibit those of the four parents. The plants in the 1889 experiments are from a muricate, a branched, and a cup-bearing form, the latter known as *peraferens*, the object being to obtain 'cups' on a branching muricate Fern, as this was a desideratum. There was no previous example of more than one cup on a frond. In the seedlings a divided frond can be observed with cups on each division, a tasselled form with a rosette in place of an actual cup, and in another example a marginal row of small cups: all are muricate. It is worth remarking that the seedlings from mixed spores never seem to produce any plants that exactly resemble any one variety, they are all combinations; in other words,

antherozoids from a number of different antheridia have helped in these fertilisations. In sowing varieties of the Lady Fern, I have raised the combination of five and six. This is alluded to in my paper 'On Prothalli.' These plants that gave evidence of multiple parentage were obtained in the identical manner formulated before they had any existence. Spores require to be sown thickly to enable the prothalli to intermingle, otherwise they are only fertilised from the same prothallus.

"If we take the reasoning of Sir John Herschel on the doctrine of probability and apply it to these trials, the chances against the view adopted being incorrect are as great as that of the haphazard distribution of the stars.

"These experiments regarding the changes in animal and vegetable life were commenced forty years ago. Bearing to some extent on this subject, experimenting on the mimulus, a yellow variety was crossed with a spotted one, and the seedlings were spotted; later on, and further up the same stem, two blooms were then crossed with a yellow one, but the seedlings were still spotted. The effect of the first cross had become a part of the life-history of the plant; in a second experiment the same plant was simultaneously crossed with pollen from two other varieties, and several of the seedlings are combinations of the three. It requires dexterity in crossing the mimulus, as the lips of the pistil are as sensitive as the leaves of the sensitive mimosa. Natural changes are slow, but culturally we can accelerate that process which continues age after age. The germ once changed, the new element is retained, it becomes combined with others until the normal appearance is lost. The illustration of the Hart's-tongue shows this alteration, helped on as it were by artificial means that have accelerated the process, and these changes will continue whilst the world lasts. Darwin sowed the seed, and his followers are reaping a plentiful harvest.

"Affectionate respect causes tablets to be erected in memory of the departed, but age obliterates such records. It is, however, far different with the philosopher who has discovered great truths: he has erected a monument to himself 'more lasting than brass!' Time wears away the hardest rock, but it will require the crumbling of this world to obliterate the truths that have been taught by Charles Darwin."

At the Fern Show of the Royal Horticultural Society in 1890, the only Silver Challenge Cup awarded was to the author, and this had to be again contested for in 1891, on which occasion it was again awarded to him.

It was at this exhibition that the idea originated to hold a Fern Show in 1892 on a different principle. Instead of awarding a silver cup for the best collection, it was proposed to offer a number of gold, silver, and bronze medals to a certain number of varieties of each species. It was said that no one could compete with so large a collection of specimens as were in the author's collection. Major Cowburn stated his opinion that if Ferns were shown in a number of classes, the same collection of Ferns would again prove successful. Major Cowburn agreed to assist in obtaining subscriptions for this object, on condition that the author would act as secretary; and he, the author, and the late Mr. E. F. Fox drew up a schedule of prizes that was submitted to Mr. James Moly, Mr. Druery, Mr. Neill Fraser, Dr. Stansfield, Mr. Phillips, Mr. Praeger, Messrs. Birkenhead, and finally adopted.

Major Cowburn also suggested that this was an occasion when several eminent Pterologists, who were, alas! now no more, might, with great propriety, have their labours recognised in some lasting manner; and this was accomplished by having several memorial prizes, and these prizes represented

those species and varieties in which each had accomplished so much. Sad to relate, Major Cowburn died before this show took place, and the world lost a valuable and universally esteemed Pterologist.

It seems desirable to enter fully into the details of this show, as it was supported by a large number of persons interested in British Ferns.

ROYAL HORTICULTURAL SOCIETY, EXHIBITION OF BRITISH FERNS, AT THE SOCIETY'S GARDENS, CHISWICK, W.,

Tuesday and Wednesday, August 23rd and 24th, 1892.

SCHEDULE.

Special Medal Prizes offered by British Fern Growers to Amateurs of the United Kingdom for *specimens* of the best *varieties* of British species, with the object of creating a greater interest in our native Ferns.

*** *Note.*—S. G. F. indicates Silver Gilt Flora Medal; S. F., Silver Flora Medal; B. F., Bronze Flora Medal; S. B., Silver Banksian Medal; B. B., Bronze Banksian Medal.

CLASS A.—Colonel A. M. Jones's Memorial Prize for 10 plumose varieties (no restriction of species). Given by his daughters and Capt. Stafford Jones. S. G. F. Won by the author.

CLASS B.—Mr. Edwin Fydell Fox's Memorial Prize for 10 cruciate or narrow varieties (no restriction of species). Given by his sons, Dr. E. Churchill Fox and Dr. Arthur E. W. Fox, and his brother, Mr. G. F. Fox. S. G. F. Won by the author.

CLASS C.—Mrs. Maria Grant's Memorial Prize for 10 varieties of *Athyrium Filix-fœmina*. Given by her son, Mr. W. J. A. Grant. S. G. F. Won by the author.

CLASS D.—Mr. William Charles Carbonell's Memorial Prize for 10 varieties of *Polystichum aculeatum* and hybrids with *P. aculeatum*. Given by "the Family." S. G. F. Won by the author.

CLASS E.—16 varieties (no restriction of species). Given by the Clifton Zoological Gardens, Mr. E. J. Lowe, F.R.S., and Major Cowburn, F.R.H.S. First prize, S. G. F. Won by the author.

CLASS F.—16 dwarf or congested varieties (no restriction of species). Given by the Hon. Mrs. Brassey, F.R.H.S., and Mrs. A. Hodgson. First prize, S. F. Won by the author.

CLASS G.—8 varieties (no restriction of species). First prize, S. F. Won by the author.

CLASS H.—8 varieties of *Nephrodium Filix-mas* (including *N. paleaceum*). First prize, S. F. Won by the author. Classes G and H given by Mr. W. Barnard Hankey, F.R.H.S.; Mr. C. T. Druery, F.L.S.; Mr. R. A. Thompson; Mr. E. T. Pease; and Mr. A. E. G. Way.

CLASS I.—10 varieties of *Scolopendrium vulgare*. First prize, S. F. Won by the author.

CLASS K.—8 varieties of *Polystichum angulare*. First prize, S. F. Won by the author. Classes I and K given by Mr. Jonathan Rashleigh, F.R.H.S.; Lord Llangattock, F.R.H.S.; Mr. R. Clive, F.R.H.S.; Mr. P. Neill Fraser, F.R.S.E.; and Mr. W. B. Boyd.

CLASS L.—8 crested or capitate varieties (no restriction of species). Given by Mr. J. W. Leavers, F.R.H.S.; Mr. F. J. Clark, F.L.S.; and Dr. Stansfield. First prize, S. F. Won by the author.

CLASS M.—4 varieties, restricted to species not included in C, D, H, I, K, N, or Q. Given by Alderman Ellis, Mr. W. S. Lang, and Mr. O. Firth. First prize, B. F. Won by the author.

CLASS N.—4 varieties of *Polypodium vulgare*. Given by Mr. W. Birkenhead, F.R.H.S.; and Mr. J. Birkenhead, F.R.H.S. S. F. Won by Mr. W. Marshall.

CLASS O.—8 rugose or muricate varieties (no restriction of species). Given by Mr. J. E. Mapplebeck, F.L.S. First prize, S. B. Won by the author.

CLASS P.—4 *Adiantums*. Given by Mrs. Thomas. B. F. Won by the author.

CLASS Q.—10 wild varieties of *Aspleniums* (including *Ceterach*). Given by Mr. P. B. O'Kelly. B. F. Won by the author.

Best specimen. Given by Mr. W. H. Phillips. B. F. Won by Mr. W. Marshall.

,, variety. Given by Mr. R. Lloyd Praeger, M.R.I.A. B. F. Won by Mr. C. T. Druery.

,, variegated or golden variety. Given by Mr. James Moly. B. F. Won by the author.

,, Hybrid variety. Given by Mr. G. Harris. B. F. Not awarded.

,, *Athyrium*. B. B. Won by Mr. C. T. Druery.
,, *Scolopendrium*. B. B. Won by the author.
,, *Nephrodium*. B. B. Won by the author.
,, *Polystichum*. B. B. Won by the author.
,, *Osmunda*. B. B. Won by the author.
,, *Polypodium*. B. B. Won by Mr. W. Marshall.

These prizes given by Mr. John Loraine Baldwin.

Best *Adiantum.* B. B. Won by the author. Given by Mr. J. H. Fitt.
„ *Asplenium.* B. B. Won by the author. Given by Mr. G. Gillett.

At the National Fern Conference of the Royal Horticultural Society, held at Chiswick, July 22nd and 23rd, 1890, the author received the following special Certificates of Merit, viz. :—

Adiantum Capillus-Veneris, var. *autumnale.*
Asplenium Filix-fœmina, var. *calomelanos.*
„ „ var. *columnare.*
„ „ var. *coronare.*
„ „ var. *cruciatum.*
„ „ var. *magnificum.*
„ „ var. *Victoriæ-gracile.*
1* Aspidium aculeatum, var. *Abbottæ.*
„ „ var. *hybridum.*
2† „ „ var. *pulcherrimum.*
„ angulare (section decompositum) var. *frondosum.*
„ „ (section divisilobum) var. *plumosum.*
„ „ (section divisilobum-plumosum) var. *Baldwini.*
„ „ (section „ „) var. *imbricatum.*
3‡ „ „ (section laciniatum) var. *flabellipinnulum.*
„ „ (section latifolium) var. *grandiceps.*
„ „ (a hybrid) var. *Nepos.*
„ „ (section plumosum) var. *plumosissimum.*
„ „ (section „) var. *coronare.*
„ „ (section „) var. *foliosum.*
„ „ (section polydactylum) var. *variegatum.*
4§ „ „ (section lineare) var. *remoto-decurrens.*
5‖ Nephrodium paleaceum, var. *crispatum.*
6¶ „ „ var. *pendens.*
7** „ spinulosum, var. *spectabile.*

1* Found near Bristol by Mrs. Abbott, and brought under notice by the late Colonel Jones.
2† Found by the late Mr. Wills.
3‡ Found in Dorset by the late Mr. Wills.
4§ Found by Mr. James Moly.
5‖ Found near Bettws-y-Coed by Mrs. Boyle.
6¶ Found by Mr. Ranyard.
7** Found on Ben Lawers by the author.

Scolopendrium vulgare, var. *Alexandra.*
" " var. *angustatum.*
" " var. *aureolum.*
" " var. *capitatum.*
8* " " (section crispum) var. *Cowburni.*
" " var. *grandiceps.*
" " var. *luminare.*
" " var. *muricato-spirale.*
" " var. *pericalles.*
" " var. *princeps.*
9† " " (section crispum) var. *reflexum.*
10‡ " " (section ") var. *robustum.*
" " var. *rosetta.*
" " var. *synthesina.*
11§ Trichomanes radicans, var. *crispo-cristatum.*

(All the above, and those in the succeeding lists, were raised from spores, except those marked * &c., as wild-found varieties.)

The following of the author's Ferns have also received first-class certificates by the Royal Horticultural Society :—

Adiantum Capillus-Veneris, *Admirabile* (Lowe), 1871.
" " *angustatum* (Lowe), 1872.
12‖ " " *daphnites* (Lowe), 1871.
" " *imbricatum* (Lowe), 1872.
" " *kalon* (Lowe), 1868.
13¶ " " *multiceps-dentatum* (Lowe), 1872.
" " *optandum* (Lowe), 1872.
" " *perfectum* (Lowe), 1871.
Aspidium aculeatum, *acrocladon-majus* (Lowe), 1871.
" " *adrastia* (Lowe), 1891.
" " *honorabile* (Lowe), 1892.

8* Found at Dennel Hill, Gloucestershire, by the late Major Cowburn.
9† Found by the late Mr. Wills.
10‡ Found near Shirenewton by the late Colonel A. M. Jones.
11§ Found in Ireland by the late Colonel Arthur S. H. Lowe.
12‖ From spores given to the author by Sir Joseph Hooker.
13¶ Found in the Galway Mountains by Mr. Kinahan (Irish Geological Survey).

14* Aspidium angulare (section setosum) *gracile* (Lowe), 1891.
„ „ *transforme* (Lowe), 1871.
15† Asplenium adiantum-nigrum, *grandiceps* (Lowe), 1868.
16‡ „ ceterach, *multifido-cristatum* (O'Kelly), 1891.
17§ „ Filix-fœmina, *abasiphyllum*, (Lowe), 1868.
„ „ *Albertii* (Lowe), 1872.
„ „ *Alexandræ* (Lowe), 1871.
„ „ *amœnum* (Lowe), 1869.
„ „ *Arthuri* (Lowe), 1872.
„ „ *Bellairsæ* (Lowe), 1871.
„ „ *centiceps* (Lowe), 1872.
18‖ „ „ *diffisum* (Moore), 1869.
19¶ „ „ *Edwardsii* (Lowe), 1869.
„ „ *Edwardsii-ramosum* (Lowe), 1872.
„ „ *exempluum* (Lowe), 1870.
„ „ *Fraseri* (Lowe), 1869.
„ „ *Gulsonæ* (Lowe), 1871.
„ „ *Hookeri* (Lowe), 1869.
„ „ *invincere* (Lowe), 1871.
„ „ *Kallisteumaton* (Lowe), 1870.
„ „ *Kalliston* (Lowe), 1869.
„ „ *Kalon* (Lowe), 1869.
„ „ *Kephalobares* (Lowe), 1870.
„ „ *Kladodesteron* (Lowe), 1868.
„ „ *Lawsoni* (Lowe), 1871.
20** „ „ *Longridgense* (Lowe), 1868.
„ „ *Lowæ* (Lowe), 1871.
„ „ *Lowæ-angustatum* (Lowe), 1872.
„ „ (section lunulatum) *Nellie* (Fox), 1891.
„ „ (section cruciatum) *Regale* (Lowe), 1868.
„ „ *Rickettsiæ* (Lowe), 1869.
„ „ *secale* (Lowe), 1871.
„ „ *strombomenon* (Lowe), 1870.

14* Found in Ireland by Mr. W. H. Phillips.
15† Found in Ireland by the Rev. Travers Smith.
16‡ Found in Ireland by Mr. P. B. O'Kelly.
17§ Found in Ireland by the late Rev. C. Padley.
18‖ Found in Guernsey by the late Mr. James.
19¶ Found in Ireland by the late Mr. Riley.
20** Found in Lancashire by the author.

Asplenium Filix-fœmina, *todeoides-superbum* (Lowe), 1872.
„ „ *triumphale* (Lowe), 1871.
„ „ *trossulum* (Lowe), 1871.
„ „ *Victoriæ-elegans* (Lowe), 1872.
„ marinum, *admirabile* (Lowe), 1870.
„ „ *capitatum* (Lowe), 1869.
21* „ „ *imbricatum* (Lowe), 1868.
„ „ *imbricatum-superbum* (Lowe), 1872.
„ „ *ramo-capitatum* (Lowe), 1873.
„ „ *ramosum-Claphami* (Lowe), 1869.
22† „ „ *Thompsonæ* (Lowe), 1871.
23‡ Hymenophyllum unilaterale, *Kinahani* (Lowe), 1871.
24§ Nephrodium (dilatatum) spinulosum, *calomelanos* (Lowe), 1871.
25§ „ „ „ *ornamentum* (Lowe), 1873.
26§ „ „ „ *spectabile* (Lowe), 1870.
27§ „ „ „ *spectabile-ramosum* (Lowe), 1871.
28‖ „ „ Filix-mas, *depauperatum-Padleyi* (Lowe), 1871.
29¶ „ „ *Fraseræ* (Lowe), 1872.
30** „ „ *variegatum* (Lowe), 1871.
31†† „ paleaceum, *acceptum* (Lowe), 1870.
„ „ *Belperi* (Lowe), 1871.
32‡‡ „ „ *magnificum* (Lowe), 1872.
33‡‡ „ „ *nitidum* (Lowe), 1868.
34§§ „ „ *Willsii* (Jones), 1891.
Osmunda regalis, *capitata* (Lowe), 1891.
„ „ *cristata-minor* (Lowe), 1872.
Scolopendrium vulgare, *acceptum* (Lowe), 1871.
„ „ *Albertii* (Lowe), 1872.
„ „ *allokoton* (Lowe), 1869.

21* Found in Wales by the late Mr. Clift.

22† Found in Devon by Mrs. Agar Thompson.

23‡ Found in Ireland by Mr. R. Kinahan of the Irish Geological Survey.

24, 25, 26, and 27 § These and eleven others found under one large cavernous stone on Ben Lawers by the author.

28‖ Found on Exmoor by the late Rev. C. Padley.

29¶ Found in Scotland by the author.

30** Found in Yorkshire by Miss Wright.

31†† Found in Scotland by the author.

32 and 33 ‡‡ Found in Scotland by the author.

34§§ Found in South Devon by the late Mr. John Wills.

Scolopendrium vulgare, *amœnum* (Lowe), 1868.
" " *areston* (Lowe), 1868.
" " *asumbleton* (Lowe), 1870.
35* " " *aureo-variegatum* (Lowe), 1868.
" " *axion* (Lowe), 1870.
" " *Babingtoni* (Lowe), 1869.
" " *blandissimum* (Lowe), 1892.
" " *capitellum* (Lowe), 1868.
" " *cochleatum* (Lowe), 1871.
" " *cochleatum cristatum* (Lowe), 1872.
" " *consummatum* (Lowe), 1871.
" " *Coolingii* (Lowe), 1868.
" " *circulum* (Lowe), 1870
" " *corolla* (Lowe), 1892.
" " *crispum decorum* (Lowe), 1891.
36† " " *crispum pendens* (Lowe), 1892.
" " *cuticulare* (Lowe), 1869.
" " *Davyi* (Lowe), 1871.
" " *decorum* (Lowe), 1867.
" " *dichotomum* (Lowe), 1868.
37‡ " " *divergens* (Lowe), 1868.
" " *dividendum* (Lowe), 1869.
" " *eupleces* (Lowe), 1870.
" " *Fellowsii* (Lowe), 1871.
" " *Flora* (Lowe), 1870.
" " *formosum* (Lowe), 1868.
" " *gloriosum* (Lowe), 1869.
" " *Hookeri* (Lowe), 1868.
" " *illustre* (Lowe), 1868.
" " *innocuum* (Lowe), 1871.
" " *inusitatum* (Lowe), 1870.
" " *kephaloton* (Lowe), 1871.
" " *keratoides* (Lowe), 1868.
" " *keratophoron* (Lowe), 1871.
" " *kompsotes* (Lowe), 1870.
" " *korumbosphoron* (Lowe), 1869.

35* Found near Ambleside by the author.
36† Found near Shirenewton by the late Colonel A. M. Jones.
37‡ Found near Dunkeld by the author, but unfortunately now dead.

Scolopendrium vulgare, *kraspedon* (Lowe), 1870.
,, ,, *krosson* (Lowe), 1870.
,, ,, *marginato-undulatum* (Lowe), 1869.
,, ,, *margine* (Lowe), 1870.
,, ,, *megeraton* (Lowe), 1870.
,, ,, *mirabile* (Lowe), 1868.
,, ,, *mirum* (Lowe), 1872.
,, ,, *Moonæ* (Lowe), 1871.
,, ,, *Moorei* (Lowe), 1868.
,, ,, *muricatum-crispum* (Lowe), 1891.
,, ,, *muricatum-reflexum* (Lowe), 1892.
,, ,, *muricatum-superbum* (Lowe), 1891.
,, ,, *notabile* (Lowe), 1868.
,, ,, *omnilacerum Lowei* (Clapham), 1871.
,, ,, *optandum* (Lowe), 1869.
,, ,, *ornamentum* (Lowe), 1869.
,, ,, (section peraferens) *nepenthesoides* (Lowe), 1891.
,, ,, *perfectum* (Lowe), 1871.
,, ,, *perikallon* (Lowe), 1870.
,, ,, *pictorum* (Lowe), 1870.
,, ,, *poluklonon* (Lowe), 1869.
,, ,, *poluskiston* (Lowe), 1870.
,, ,, *præcinctum* (Lowe), 1871.
,, ,, *proodonton* (Lowe), 1870.
,, ,, *ramo-coronatum* (Lowe), 1872.
,, ,, (section ramo-inæquale) *laudabile* (Lowe), 1891.
,, ,, (section ramo-marginatum) *Elworthii* (Lowe), 1872.
,, ,, *ramosissimum* (Lowe), 1868.
,, ,, *rugosum-Bellairsiæ* (Lowe), 1869.
,, ,, *scalpturatum-latum* (Lowe), 1868.
,, ,, *semnon* (Lowe), 1870.
,, ,, *Sherbrookei* (Lowe), 1872.
,, ,, *significans* (Lowe), 1868.
,, ,, *Smeei* (Lowe), 1871.
,, ,, *spirale-nanum* (Lowe), 1869.
,, ,, *stenomenon* (Lowe), 1868.
,, ,, *stephanedon* (Lowe), 1870.
,, ,, *summum* (Lowe), 1869.
,, ,, (section supralineatum) *Lowei* (Lowe), 1868.
,, ,, (section ,,) *Moonæ* (Lowe), 1891.

Scolopendrium vulgare, *thaumaston* (Lowe), 1869.
„ „ *Thompsoni* (Lowe), 1869.
„ „ *thusanæsson* (Lowe), 1869.
„ „ *tortum* (Lowe), 1868.
„ „ *transformatum* (Lowe), 1870.
„ „ *tridentiferum* (Lowe), 1869.
„ „ *triforme* (Lowe), 1868.
„ „ *tumulum* (Lowe), 1871.
„ „ *Victoriæ* (Lowe), 1869.
„ „ *virginale* (Lowe), 1871.

VARIETIES OF BRITISH FERNS THAT HAVE BEEN CERTIFICATED BY THE ROYAL HORTICULTURAL SOCIETY BETWEEN 1859 AND 1893.

Adiantum Capillus-Veneris, 11—(of these one was won by Veitch, one by Lee, one by Williams, and eight by the author).

Aspidium (subsection polystichum) aculeatum, 4—(one by Ivery, and the same by Mapplebeck, and three by the author).

Aspidium (subsection polystichum) angulare, 46—(*i.e.*, eight by Ivery, three by Bull, two by Birkenhead, one each by Stansfield, Mapplebeck, Thompson, Edwards, Gray, Luccombe, Veitch, and Patey, and twenty-five by the author).

Asplenium Adiantum-nigrum, 3—(one by Parsons, one by Thompson and Stansfield, and one by the author).

Asplenium Ceterach—1 (by the author).

Asplenium (subsection Athyrium) Filix-fœmina, 113—(*i.e.*, 30 by Mapplebeck, thirteen by Ivery, three by Parsons, two by Jones, four by Stansfield, seven by Bull, two by Edwards, two by Garaway, four by Shaw and Williams, two by Birkenhead, five by Druery, one each by Clapham, Moore, Girdlestone, Howlett, Veitch, and Richardson, and thirty-three by the author).

Asplenium marinum, 9—(*i.e.*, one by Mapplebeck, one by Backhouse, and seven by the author).

Asplenium Trichomanes, 2—(*i.e.*, one by Holland, and one by Stansfield).

Cystopteris fragilis, 1—(*i.e.*, by Mapplebeck).

Hymenophyllum unilaterale, 1—(*i.e.*, by the author).

Lomaria Spicant, 6—(*i.e.*, by Mapplebeck two, by Stansfield four).

Nephrodium (subsection Lastrea) dilatatum (-spinulosum), 7—(*i.e.*, by Ivery one, by Mapplebeck one, by the author five).

Nephrodium (subsection Lastrea) Filix-mas (including *paleaceum* and *abbreviatum*), 18—(*i.e.*, by Bull three, by Mapplebeck three, by Parsons two, by Ivery one, by Thompson one, by Birkenhead one, by the author seven).

Nephrodium (subsection Lastrea) montanum, 4—(*i.e.*, by Stansfield two, by Birkenhead one, by Williams one).

Osmunda regalis, 4—(*i.e.*, by Osborn two, by the author two).

Polypodium vulgare, 7—(*i.e.*, by Mapplebeck three, by Stansfield one, by Backhouse one, by Ivery one, and by Cross one).

Pteris aquilina, 4—(*i.e.*, by Mapplebeck four).

Scolopendrium vulgare, 114—(*i.e.*, by Mapplebeck nine, by Jones four, by Birkenhead two, by Ivery two, by Kelway two, by Stansfield one, by Edwards one, by Morgan one, by Malyon one, by Veitch one, by Williams one, and by the author eighty-nine).

The following Ferns have also received certificates from the Royal Horticultural Society, exhibited by others :—

Adiantum Capillus-Veneris, *imbricatum*, 1886.
„ „ *magnificum*, 1869.
„ „ *maximum*, 1870.
„ „ *undulatum*, 1869.
*Aspidium aculeatum *acrocladon*, 1864 and 1868.
„ angulare, *Bayliæ*.
* „ „ *brachiato-cristatum, Smithii*, 1870.
„ „ *confluens variegatum*, 1882.
„ „ *congestum*, 1870.
„ „ *corymbiferum*, 1860.
„ „ *cristato-gracile*, 1867.
„ „ *divisilobum Padleyi*, 1867.
„ „ „ *decorum*, 1891.
„ „ *Grayi*, 1868.
„ „ *grandiceps*, 1864.
„ „ „ *pumilum*, 1875.
„ „ *Holeanæ*, 1866.
„ „ *lineare*, 1867.

---

* Mr. J. E. Mapplebeck.

Aspidium angulare, *oxyphyllum*, 1867.
" " *parvissimum*, 1865.
" " *Pateyi*, 1868.
" " *proliferum Henleyæ*, 1882.
" " *pulcherrimum*, 1891.
" " *pulchrum Bellairsiæ*, 1871.
" " *rotundatum*, 1864.
" " *setosum*, 1866.
Asplenium Adiantum-nigrum, *flabellatum*, 1865
" " " " of Thompson, 1868.
" " " *serpentini*, 1872.
Asplenium Filix-fœmina, *achillæfolium*, 1872.
" " *acrocladon*, 1881.
" " *Applebyanum*, 1863.
* " " *bellum*, 1871.
" " *Blakei*, 1870.
* " " *caput-Medusæ*, 1870
* " " *caudiculatum*, 1871.
* " " *ceratophyllum*, 1871.
† " " *Clarissima*, 1873.
* " " *comicum*, 1870.
* " " *Craigii*, 1869.
* " " " *glomeratum*, 1891.
* " " " *splendens*, 1870.
" " *curtum*, 1865.
* " " *defecto-sectum*, 1870
* " " *densissimum*, 1870.
" " *diffiso-multifidum*, 1864.
* " " *dilatatum*, 1871.
" " *Elizabethæ*, 1868.
* " " *Elworthii*, 1869.
" " *eucephalum*, 1868.
* " " *eulophos*, 1869.
" " *Fieldiæ lancifolium*, 1864.
" " *fissidens irregulare*, 1865.
* " " *flabellifolium*, 1870.
* " " " *cristatum*, 1870.
* " " " *tenue*, 1871.

---

* Mr. J. E. Mapplebeck. † Colonel Jones.

Asplenium Filix-fœmina, *flexile*, 1872.
,, ,, *Footii*, 1867.
* ,, ,, *Fraseri glomeratum*, 1867.
,, ,, *Frizellæ*, 1861.
* ,, ,, *furcillans*, 1869.
* ,, ,, *Gillsoniæ*, 1871.
* ,, ,, ,, *flabellatum*, 1872.
* ,, ,, ,, *furcans*, 1870.
,, ,, *glomeratum*, 1863.
,, ,, *Girdlestonei*, 1867.
,, ,, ,, *cristatum*, 1891.
,, ,, *Gloveri*, 1867.
* ,, ,, *Howardæ*, 1868.
,, ,, *Iveryanum*, 1862.
* ,, ,, *Jonesii*, 1870.
,, ,, *kallothrix*, 1869.
* ,, ,, *Mapplebeckii*, 1869.
,, ,, *mucronatum*, 1862.
,, ,, *multiceps*, 1859.
,, ,, *Parsoniæ*, 1862.
* ,, ,, *paucidentatum abruptum*, 1872.
,, ,, *Peaseanum*, 1867.
,, ,, *plumosum*, 1860.
,, ,, ,, *Axminsterense*, 1867.
‡ ,, ,, ,, *Drueryi*, 1891.
,, ,, ,, *multifidum*, 1867.
,, ,, *proliferum*, 1866.
,, ,, *pulcherrimum*, 1867.
,, ,, *pulchrum*, 1866.
,, ,, *ramosissimum*, 1867.
* ,, ,, *rectangulare*, 1871.
,, ,, *regale Barnes* var., 1889.
‡ ,, ,, *revolvens*, 1891.
‡ ,, ,, *rotundatum aristatum*, 1892.
,, ,, *sagittatum*, 1863.
,, ,, *scopœforme*, 1868.
,, ,, *Shawii*, 1869.
* ,, ,, *spicatum*, 1872.

---

* Mr. J. E. Mapplebeck. ‡ Mr. C. T. Druery.

Asplenium Filix-fœmina, *Stanleyi*, 1869.
„ „ *Stansfieldiæ*, 1869.
‡ „ „ *superbum densum*, 1891.
‡ „ „ „ *percristatum*, 1892.
* „ „ *torto-cristatum*, 1868.
„ „ *trifidum*, 1871.
„ „ *Vernonæ*, 1864.
† „ „ „ *cristatum Jonesii*, 1873.
„ „ *Victoriæ*, 1864.
* „ marinum *Auchmithianum*, 1869.
„ „ *plumosum*, 1886.
„ Trichomanes, *Harovii*, 1865.
„ „ *incisum triangulare*, 1865.
* Cystopteris fragilis, *gracilis*, 1868.
* Lomaria Spicant, *crispata*, 1871.
„ „ *lancefolia-anomala*, 1869.
„ „ *Mapplebeckii*, 1869.
„ „ *projecta furcans*, 1869.
„ „ *serrata rigida*, 1865.
„ „ *undulata*, 1865.
Nephrodium spinulosum, *crispum*, 1868.
* „ „ *cristatum splendens*, 1872.
„ Filix-mas, *Bollandæ*, 1862.
„ „ *cristato-crispum*, 1869.
„ „ *fimbriatum*, 1890.
„ „ *Festingii*, 1882.
* „ „ *foliosum*, 1869.
* „ „ *Mapplebeckii*, 1868.
„ „ *parvulum*, 1869.
„ „ *ramosissimum*, 1869.
* „ „ *revolvens*, 1871.
„ montanum, *coronans*, 1882.
„ „ *crispum*, 1869.
„ „ *cristatum*, 1863.
„ „ *ramo-coronans*, 1888.
Osmunda regalis, *acutiloba*, 1867.
„ „ *cristata*, 1862.
* Polypodium vulgare, *bifido-cristatum*, 1872.

---

* Mr. J. E. Mapplebeck. † Colonel Jones. ‡ Mr. C. T. Druery.

Polypodium vulgare, *Cornubiense*, 1869.
* „ „ *kraspedomenon*, 1869.
„ „ *pulcherrimum*, 1864.
„ „ *ramosum*, 1865.
* „ „ *semilacerum robustum*, 1869.
„ „ *trichomanoides*, 1886.
Pteris aquilina vars.
* „ „ *cristata Gloveri*, 1871.
* „ „ *grandiceps Mapplebeckii*, 1872.
* „ „ „ 1871.
* „ „ *incurva*, 1871.
Scolopendrium vulgare vars.
* „ „ *Cliftii*, 1868.
„ „ *crispum-fimbriatum*, 1887.
† „ „ *latissimum*, 1873.
* „ „ *latum-multifidum*, 1869.
„ „ *cristulatum*, 1888.
„ „ *digitatum-majus*, 1892.
„ „ *Edwardsii*, 1867.
* „ „ *Forsteri*, 1872.
* „ „ *Gloveri*, 1869.
* „ „ *hemionitoides*, 1869.
† „ „ *insigne*, 1873.
„ „ *Iveryanum*, 1870.
„ „ *Kelwayi*, 1868.
„ „ „ *densum*, 1882.
„ „ *lacerato-cristatum*, 1870.
† „ „ *marginato-cristatum*, 1873.
* „ „ *marginatum tenue*, 1868.
„ „ *Morgani*, 1866.
„ „ *multifidum Malyoni*, 1870.
* „ „ *obtusidentatum costale*, 1869.
† „ „ *robustum*, 1873.
* „ „ *semipinnatum*, 1869.
* „ „ *spirale*, 1868.
„ „ *Valloisi*, 1887.
„ „ *Williamsii*, 1873.

The above list will give the relative advance in the number of good varieties

---

* Mr. J. E. Mapplebeck. † Colonel Jones.

that have been added to the different species as worthy of certificates since 1859. These are all First-Class Certificates except the following :—

SILVER BANKSIAN MEDAL.

To Osborn, for an *Osmunda regalis* var.

The number of First-Class Certificates were thus awarded :—

To the Author . . .	171	Messrs. Shaw and Williams	4
Mr. Mapplebeck . .	52	Messrs. Birkenhead . .	4
Mr. Ivery	22	Mr. Thompson . . .	3
Messrs. Stansfield . .	13	Mr. Druery . . .	3
Mr. Bull	10	Messrs. Williams . .	2
Colonel Jones . . .	6	Mr. Garaway . . .	2
Mr. Parsons . . .	6	Messrs. Backhouse . .	2
Messrs. Veitch . . .	4	Messrs. Kelway . . .	2
Mr. Edwards . . .	4		

and one First-Class Certificate was won by each of the following :—

Messrs. Lee, Gray, Luccombe, Patey, Clapham, Moore, Girdlestone, Howlett, Richardson, Holland, Osborn, Cross, Morgan, and Malyon. Altogether 324 First-Class Certificates have been awarded by the Royal Horticultural Society—*i.e.*, 171 to the author, and 153 to all the other exhibitors.

The author gives this enumeration of Certificates in order to show how much can be done by carefully crossing the varieties of the different species of Ferns in a scientific manner, for in the First-Class Certificates that the author has thus won, twenty-one only were from wild-finds, whilst one hundred and fifty-one were the author's own seedlings. Then, again, the author's plants have only been at the Royal Horticultural Society's Shows eleven times—viz., at their five County Shows, 1868 to 1872, and between 1869 and 1872 three times at the London Shows ; after this the author's plants were not again at the Royal Horticultural Society until 1890, when a Cup was offered for the best collection of Ferns, and on which occasion it was awarded to the author. At this Show there were Special Awards of Merit given by the Fern Conference, but as these were omitted in the list of Certificates of the Royal Horticultural Society, 1859 to 1893, they have not been included, although at that Show forty of the author's plants received this mark of distinction (the whole awards at that Exhibition being about fifty). In 1891 the above-mentioned Cup had again to be competed for (as it had to be won twice before it could be retained), and the author's Ferns were again successful. It was at this show that the lovers and cultivators of Ferns entertained the idea, and in fact decided upon it, that another Show be held at whch the varieties should be shown in sections.

In addition, the following varieties received First-Class Certificates from the Royal Botanic Society by the author :—

Asplenium Adiantum-nigrum var. *grandiceps*, 1868.
„ marinum var. *decorum*, 1868.
„ „ var. *imbricatum*, 1868.
„ Filix-fœmina var. *abasiphyllum*, 1867.
Asplenium Filix-fœmina var. *Edwardsii*, 1867.
„ „ var. *umbraculæforme*, 1867.
Scolopendrium vulgare var. *ariston*, 1868.
„ „ var. *dichotomum*, 1868.
„ „ var. *formosum*, 1867.
„ „ var. *illustre*, 1868.
„ „ var. *marginato-undulatum*, 1867.
„ „ var. *Moorei*, 1868.
„ „ var. *notabile*, 1867.
„ „ var. *omnilacerum*, 1867.
„ „ var. *tortum*, 1868.
„ „ var. *stenomenon*, 1867.

At the British Association Floral Fête at the Nottingham Meeting in 1866 (at which Mr. Thomas Moore, of the Chelsea Botanic Gardens; Mr. Thomas Speed, Chatsworth Gardens; and Mr. Westland, of Witley Court, were the judges), the following varieties received First-Class Certificates :—

The Rev. C. A. A. Padley for—

Polystichum angulare, *dissimile*, *parvissimum*, *inæquale*, *reflexum*, *variegatum*, *formosum*, *glomeratum*, *orbiculatum*, *vestitum*, and *plumosum*; Scolopendrium vulgare, *variegatum* and *undulato-variabile*; Polystichum aculeatum, *grande*; Nephrodium paleaceum, *ramosum*; Athyrium Filix-fœmina, *cordatum*; and Asplenium Trichomanes, *Moulei*.

Lord Belper for—

Nephrodium paleaceum, *Westlandii*.

Mr. Edwards for—

Scolopendrium vulgare, *Moorei*.

Mr. E. Cooling for—

Scolopendrium vulgare, *Coolingii*.

The Author for—

Asplenium Trichomanes, *incisum-Claphami* and *interruptum*; Scolopendrium vulgare, *Hookeri*, *crispum-incisum*, and *tortuoso-cristatum*; Athyrium Filix-fœmina, *Longridgense*, *digitatum*; Polypodium vulgare, *Daubenyense*; Nephrodium spinulosum, *ebeneum*; and Asplenium marinum, *imbricatum*.

Varieties that the author has received First-Class Certificates for at the Floral Fêtes of the British Association :—

Adiantum Capillus-Veneris var. *kalon*, Norwich, 1868.
Asplenium Adiantum-nigrum var. *grandiceps*, Norwich, 1868.
„ marinum var. *imbricatum*, Nottingham, 1866.
38* „ Trichomanes var. *Claphami*, Nottingham, 1866.
„ „ var. *interruptum*, Nottingham, 1866.
„ Filix-fœmina var. *Longridgense*, Nottingham, 1866.
„ „ var. *mirandum*, Norwich, 1868.
„ „ var. *trossula*, Bath, 1888.
Nephrodium spinulosum var. *ebeneum*, Nottingham, 1866.
39† „ Filix-mas var. *Cronkleyense*, Norwich, 1868.
40‡ „ „ var. *rotundatum*, Norwich, 1868.
41§ Lomaria Spicant var. *imbricatum-Cliftii*, Dundee, 1867.
„ „ var. *kalon*, Dundee, 1867.
Polypodium vulgare var. *calomelanos*, Bath, 1888.
„ „ var. *Daubenyense*, Nottingham, 1866.
Aspidium aculeatum var. *cruciatum*, Bath, 1888.
„ „ var. *Rileyæ*, Norwich, 1868.
42‖ „ angulare var. *Buckleæ*, Norwich, 1868.
„ „ var. *flabellipinnulum*, Bath, 1888.
„ „ *ariprepes*, 1871.
„ „ *attractum*, 1892.
„ „ *coronale*, 1869.
„ „ (section cristatum) *circumglobatum*, 1891.
„ „ (section „) *hybridum*, 1891.
„ „ (section cruciatum) *Nympha*, 1891.
„ „ (section grandiceps) *coronale*, 1891.
„ „ (section „) *tæda*, 1891.
„ „ *inaccessum*, 1892.
„ „ *laudatum*, 1868.
„ „ (section lineare) *laxum*, 1869.
„ „ *longipinnatum*, 1892.

38* Found in Yorkshire by the late Mr. A. Clapham and Mr. Tatham.
39† Found in Teesdale by the author and Colonel A. S. H. Lowe.
40‡ Found near Whitby by the author.
41§ Found in North Wales by the late Mr. Clift.
42‖ Found in Yorkshire by Mrs. Buckler.
43¶ Certificates marked 1891 and 1892 refer to the Royal Horticultural Society.

Aspidium angulare, *mousogenes*, 1870.
,, ,, *nidum*, 1868.
,, ,, *oxyphyllum Elworthii*, 1869.
,, ,, *pictorum*, 1871.
,, ,, (section plumosum) *angustatum*, 1892.
,, ,, (section plumoso-divisilobum) *gracile*, 1891.
,, ,, (section ,, ,,) *robustum*, 1892.
,, ,, (acutilobum) *conspicuum*, 1871.
,, ,, (section plumosum) *Rhea pinnæ*, ostrich plume.
,, ,, *Rileyæ*, 1892.
,, ,, (section rotundatum) *erectum*, 1871.
,, ,, var. *laudatum*, Norwich, 1868.
Aspidium angulare var. *rotundato-cruciatum*, Bath, 1888.
Scolopendrium vulgare var. *adornatum*, Bath, 1888.
,, ,, var. *allokoton*, Norwich, 1868.
,, ,, var. *crispum-incisum*, Nottingham, 1866.
43* ,, ,, var. *Cliftii*, Norwich, 1868.
,, ,, var. *Coolingii*, Nottingham, 1866.
,, ,, var. *coronale*, Dundee, 1867.
,, ,, var. *dichotomum*, Norwich, 1868.
,, ,, var. *formosum*, Dundee, 1867.
,, ,, var. *Hookeri*, Nottingham, 1866.
,, ,, var. *illustre*, Norwich, 1868.
44† ,, ,, var. *marginato-undulatum*, Norwich, 1868.
,, ,, var. *Moorei*, Dundee, 1867.
,, ,, var. *mirum*, Bath, 1888.
,, ,, var. *notabile*, Dundee, 1867.
,, ,, var. *omnilacerum*, Norwich, 1868.
,, ,, var. *plecomenon*, Norwich, 1868.
45‡ ,, ,, var. *scalpturato-latum*, Norwich, 1868.
,, ,, var. *supralineatum Lowei*, Norwich, 1868.
,, ,, var. *tortum*, Norwich, 1868.
,, ,, var. *triforme*, Dundee, 1867.
,, ,, var. *stenomenon*, Nottingham, 1866.
,, ,, var. *tortuoso-cristatum*, Nottingham, 1866.

43* Found in North Wales by the late Mr. Clift.
44† Found at Heversham Head by the late Mr. J. M. Barnes.
45‡ Found near Scarborough by the author.
(The reference numbers from 38 to 45 are in continuation of those in the Royal Horticultural Society's list.)

BRITISH ASSOCIATION FLORAL FETE, BATH, 1888.

(Report from the *Gardeners' Chronicle.*)

"The most conspicuous feature was that of British Ferns. The unique varieties of Colonel Jones, of Clifton, and of Mr. E. J. Lowe, F.R.S., of Shirenewton Hall, near Chepstow, made a grand display, numbering some hundreds of well-grown plants. All the First and Second Prizes were taken by these two gentlemen, who between them also secured thirty First-Class Certificates for very distinct new varieties. New Ferns also came from twelve other well-known growers. Such a collection has never been before brought together.

"The following is the list of First-Class Certificates awarded: *—

Mrs. Abbot, The Priory, Abbots Leigh, near Bristol, for—
Aspidium aculeatum (section grandiceps) *Abbotæ.*

Mr. J. M. Barnes, Levens, Milnthorpe, Westmoreland, for—
Polypodium vulgare var. *multifido-elegantissimum.*
„ „ var. *folioso-cornubiense.*
„ „ var. *bifido-grandiceps.*
Nephrodium abbreviatum var. *grandiceps.*
„ montanum var. *coronans.*
Asplenium Filix-fœmina var. *regale.*
„ „ var. *plumosum Barnesii.*

Mr. W. C. Carbonell, Usk, for—
Aspidium angulare var. *divisilobum-grandiceps.*

Mr. C. T. Druery, F.L.S., Fernholme, Forest Gate, Essex, for—
Lomaria Spicant var. *concinna.*
„ „ var. *ramo-cristata.*

Mr. Fitt, the Frythe Gardens, Welwyn, Herts, for—
Nephrodium paleaceum var. *ramo-cristatum.*

Mr. E. F. Fox, Brislington, Bristol, for—
Aspidium aculeatum var. *corymbiferum.*
„ „ var. *corymbiferum-cruciatum.*
„ angulare var. *congesto-polydactylum.*

Mr. Garnett, Bowness, Windermere, for—
Asplenium Filix-fœmina var. *setigerum-cristatum.*

---

* The author is not responsible for any names, except of those exhibited by himself: some contain from thirty to forty letters, and are the reverse of euphonical.

Mr. Gill, The Fernery, Lynton, Devon, for—
Nephrodium æmulum var. *cristatum.*

Mrs. Grant, Hillersdon House, Cullompton, Devon, for—
Scolopendrium vulgare var. *crispum-variegatum.*

Colonel A. M. Jones, Staffa House, Clifton, for—
Asplenium Filix-fœmina var. *unco-Craigii.*
Aspidium aculeatum var. *polydactylum.*
„ angulare var. *frondoso-cruciatum.*
„ „ var. *acutilobum-cruciatum.*
„ „ var. *cruciato-polydactylum.*
„ „ var. *frondoso-bulbiferum.*
„ „ var. *decompositum-magnificum polydactylum.*
„ „ var. *divisilobum polydactylum.*
„ „ var. *decompositum-splendens polydactylum.*
„ „ var. *multilobum-polydactylum.*
„ „ var. *inæquale-variegatum polydactylum.*
„ „ var. *divisilobum elegans.*
„ „ var. *latifolium grandiceps.*
„ „ var. *polydactylum grande.*
„ „ var. *divisilobum plumosum robustum.*
„ „ var. *folioso-cristatum.*
Scolopendrium vulgare var. *crispum latissimum.*
„ „ var. *crispum robustum.*
Nephrodium paleaceum var. *grandiceps.*

Mr. E. J. Lowe, F.R.S., Shirenewton Hall, Monmouthshire, for—
Trichomanes radicans var. *crispo-cristatum.*
Aspidium angulare var. *flabellipinnulum.*
„ „ var. *coronare.*
„ „ var. *rotundato-cruciatum.*
„ aculeatum var. *hybridum.*
Scolopendrium vulgare var. *mirum.*
„ „ var. *adornatum.*
„ „ var. *circulum.*
Asplenium Filix-fœmina var. *mirandum.*
„ „ var. *trossula.*

Mr. James Moly, Langmoor, Charmouth, Dorset, for—
Aspidium angulare var. *lineatum.*
„ „ var. *cristato-gracile.*
„ „ var. *latifolium.*

Aspidium angulare var. *grandiceps.*
Scolopendrium vulgare var. *variegatum.*

Mr. Moule, Ilfracombe, Devon, for—
Scolopendrium vulgare var. *coronans.*
„ „ var. *crispum-fertile.*
Cystopteris fragilis var. *cristatum.*

Messrs. F. W. and H. Stansfield, Fern Nursery, Sale, Lancashire, for—
Asplenium Filix-fœmina var. *laciniato-ramulosum.*
„ „ var. *congestum laciniato-cristatum.*
„ „ var. *congestum-excurrens.*
„ „ var. *angustato-congestum.*
„ „ var. *unco-glomeratum.*
„ „ var. *plumosum divaricatum.*
Aspidium angulare var. *pulcherrimum.*"

ON THE CROSSING OF FERNS, AND THE INTERESTING RESULTS OBTAINED AFTER MANY YEARS' CAREFUL INVESTIGATION.

In writing a history of the crossing of Ferns, and in giving an account of the various successes that have been attained, it is necessary in the first place to point out that distrust and disbelief have persistently met these experiments, although step by step these truths have been gradually acknowledged after long intervals of time.* The simple statement that the author could cross different varieties of Ferns was disbelieved, and said to be an impossibility, and it was confidently stated that the male sperms from one prothallus escaped from their antheridia by simple rupture, or were propelled with so little force, that they could only fall on the surface of the same prothallus, and there swim about in its dampness until the female cell was found ; therefore they could not extend their journey to another prothallus, which was requisite to effect a cross, however close it might be.

Nearly forty years ago the author exhibited a large number

* These cautious proceedings on the part of our leading specialists as regards new evolutional views cannot, however, be complained of.

of crossed varieties, such as no one else possessed, and with them showed the varieties from the combination of which they had been produced. Mr. Thomas Moore, of the Apothecaries' Gardens, Chelsea, gave his opinion that they were undoubtedly produced from the parents shown, that the life-blood of both was apparent in above a hundred examples, but how this was accomplished he could not say, though he did not believe in any one being able to impregnate a Fern; and this well-known authority repeated his conviction twenty years later, on returning a paper that the author had presented to the Linnean Society, and added that a number of botanists who were present had formed the same opinion of "not proved." This paper, with the mature examples as illustrations, was returned to the author with an intimation that the Linnean Society had refused to have it printed. The author had submitted it, before sending, to experts in Fern-raising from spores, and amongst those who examined its statements was the late Mr. Abraham Clapham, of Scarborough (a gentleman who had disbelieved in crossing Ferns, but who had a short time previously acknowledged that his judgment had been changed, and that he could see this had been accomplished), the late Colonel Jones, and the late Mr. E. F. Fox, who were then both repeating these experiments, and were confident about obtaining the same conclusions, and the year after the rejection of the paper by the Linnean Society they had each succeeded in accomplishing the same result. Two years later Sir Joseph Hooker wrote to the author that "the crossing of Ferns was an acknowledged fact."

The author had next to report on having succeeded in producing multiple impregnations, and this again was stoutly resisted on the grounds that one sperm alone crossed a germ, and when once this was accomplished there was an end to this part of the process. The author had suggested that if only one sperm was requisite to cross a germ, why could not

several germs be crossed on the same prothallus; but to this it was said that if all the others were crossed, this would come to nothing, as only one germ would produce fronds. The author had seen reason to doubt this fact, and was at the time endeavouring to obtain proofs. The author had taken various-sized (*i.e.*, various-aged) prothalli, and cut them into two, three, and four pieces, and had succeeded in growing them. Some *had* previously received impregnation and some *had not;* of two examples, one with three divisions, out of a batch of spores that included a mixture of eight different varieties of the Lady Fern, and another of three varieties of the Hart's-tongue, fronds were produced on all the three divisions of the one prothallus (*i.e.*, of the Lady Fern), and on two of the Hart's-tongue. In both cases the varieties were identically the same, and in the case of the Lady Fern the evidence was overwhelming; there had been produced from this one prothallus *three plants* (before said to be an impossibility), not only *exactly alike*, but *a new variety*, differing in an extraordinary manner from all others. The plants had two kinds of fronds, and in the two fronds could be distinctly seen characters of six of the varieties that had been sown together, part of them on the one frond and part on the other, the most marked feature of distinction being that in one case the frond was acuminate and in the other truncate. These three plants are now, and have been for some time, fully grown specimens; they were all produced from the divisions of the one prothallus, and thus have not only proved that more than one plant can be raised from the same prothallus, *i.e.*, more than one cell can become fertile, but that either a number of sperms assisted in the impregnation of three cells, or that one or more different sperms had impregnated several cells, and that by assimilation the effect was spread over the whole prothallus. If only a single sperm in each cell, then *at least five* cells had been impregnated by a sperm from each of the

five varieties, the sixth character being obtained from the germ. In the latter case two of these cells did not germinate. Judging of the case from the doctrine of probability, more than one sperm must have landed in one or more of the female cells, because almost the same number of spores from the eight varieties were sown together. Now, if only five of the varieties had deposited sperms (one in each cell), the chances against this would be 120 to 1 ; if six, this would be increased to 720 to 1 ; and if we take into consideration the whole of the eight varieties, it would be 40,320 to 1. We are therefore strengthened in the conclusion that it is requisite for a number of sperms to impregnate each cell.

In a series of experiments, using a mixture of equal amounts of spores of four distinct varieties, the result has invariably been alike, viz., that in a large number of seedlings only one or two are found to show the characters of the four parents, an increased though still a small number, of three out of the four parents, and the remainder only combinations of two. In these experiments no single individual was like any *one* of the varieties that had been sown together. If only a single sperm impregnated a cell, we should have a number of plants in which the sperm had impregnated a cell on its own prothallus, and in not a single instance has this occurred. Another reason for the conclusion that more than one sperm had impregnated the cell is the fact that, where we have obtained plants showing the four varieties, we still do not raise two alike, and this seems to affirm that the variation is caused by a percentage of the sperms of any one variety predominating.

Amongst the objectors to multiple parentage Mr. G. B. Wollaston considered that only a cross between two varieties could be obtained, and that the other peculiarities were the result of a previous cross. Professor Vines and others considered that the experiments should be made with plants

that had none of this previous cross. If the result were obtained accidentally, Mr. Wollaston's idea might be correct; but if the same results are obtained over and over again, this could not, by the same reasoning on the doctrine of probability, be possible. Take the example of the mixing of the four varieties of Scolopendrium (viz., a muricate, a crested, a spiral, and an undulate form): now, if only two of these varieties effected the cross, and the other peculiarities were due to previous crosses, how is it that the peculiarities are restricted to these four varieties? Why do we not get other peculiarities that are spread through the hundreds of other varieties of Scolopendriums, and how is it that, if we sow from every one of the varieties carefully kept separate, our seedlings are mostly a copy of the variety we have sown?

No matter how much different blood we have in a variety, it is a fixed quantity, and may be treated the same as if it were a single cross.

A muricate and a normal but crested variety produce muricate-crested forms, not all alike, but all muricate and crested, and bearing a great resemblance to each other.

If we add an undulate one amongst our spores, we have a portion that are muricate, undulate, and crested, but by far the greatest number are either muricate-crested, muricate-undulate, or undulate-crested; and if, in addition, we add spores of a variety with a spirally twisted apex, we obtain a few (very few) seedlings that are muricate, undulate, and crested, with the crestings spirally twisted, a rather greater number undulate, muricate, and crested, or undulate, crested, and spirally twisted, but by far the greater number only a combination of two of the varieties; but we never get any departure from the peculiarities of these four varieties,* showing any other extreme forms that have not been sown.

* *I.e.*, we only obtain some slight variation, and these are undoubtedly owing to previous crosses.

To set the question at rest with regard to previous crossings having anything to do with these multiple complications, the author made a number of experiments by sowing the spores of these multiple crosses separately. The examples which the author now quotes give us everything that we require. They are varieties of Hart's-tongue Ferns, viz. :—

1. *Darwiniana*, the combination of four varieties.
2. *Quadriparens*, the combination of four varieties.
3. A variety having the murications on the under-side of the fronds, whilst the upper surface is smooth. (This is a new departure in character, being the reverse of the muricate forms hitherto known, and has moreover elongated triangular fronds.)

The *Darwiniana* seedlings are all *Darwiniana*, those from *quadriparens* all *quadriparens*, whilst those from the third variety, having its murications underneath, are also exact copies of their parent.

Many other experiments made at the same time might be quoted, but they would simply be repetitions of these confirmations.

So great a consensus of proof is, or ought to be, difficult to confute. It has been attained by the work of thirty-five years of experiments, repeated over and over again, taken with the greatest care, and with the object of establishing certain facts that revealed themselves from the first.

There is no more difficulty now in acknowledging multiple crossing than there was only a short time ago in denying that Ferns could be crossed.

Certain beliefs have been held as regards the reproduction of plants, and because the present discoveries are more or less opposed to those views, the discoveries themselves are received with doubt; but why there should not be a vast difference in the reproduction of plants that have two lives, the prothalloid and the frond life, it is difficult to understand.

Mr. Druery's discovery of apospory in Ferns is a case in point. We know that in the lowest orders of organisation we do not see any reproductive organs, and that fully developed forms break into separate pieces, each of which becomes a distinct individual; between this and the ordinary manner of reproduction both in the animal and vegetable kingdoms, which are so well understood, we have the families of Ferns, acknowledged to have *two separate existences*, the prothalloid life and the frond life; and also it is known that, differing from the higher forms of existence, they have in the prothalloid life *a number of* female and male organs, instead of only one. Why should only a single sperm from any one of these male organs be able to impregnate a single female cell, or why should not more than one female cell become impregnated? The natural conclusion must be that, as multiples of these organs are formed, they are for the purpose of multiple impregnation.

In nature, varieties of Ferns are the exception, the normal species predominating, and therefore young plants are as normal as their parents; yet, as in every other rule, there are exceptions, for Mr. Padley found in one lane more than fifty crested Polystichums more or less alike, being so abundant that the seedlings found in this lane were crested. Mostly only one solitary example is found of any peculiar wild variety. Mr. Phillips, however, found a batch of the Royal Fern having revolved fronds. In the neighbourhood of Shirenewton the normal form of the Hart's-tongue has partially undulate fronds. The Troggy variety of the *Asplenium Trichomanes* is the only form of *Asplenium Trichomanes* where it grows. In the sea-caves at Auchmithy, near Arbroath, the only form of the Sea Spleenwort is one with prominent ribs; the ordinary form is not to be found, although the caves are full of plants of this species.

Along the sea-coast at Dawlish there is a locality in which

the tips of the Scolopendriums are all forked, and the same peculiarity is found in a lane at Westward Ho.

These are a few instances which illustrate that an abnormal form may in time become the ordinary form of the locality. The process is slow, because the mortality must be very great where the seedling plants have to take care of themselves. In the millions of spores that are scattered from one plant, most of them fall either where there are no favourable places for their growth, where accidents of climate, &c., destroy them after they have commenced to germinate, or where other plants more vigorous than themselves have smothered them out of existence.

Let us take the case of the peculiar cruciate Lady Fern known as *Victoriæ* or the crested Male Fern (*Nephrodium paleaceum* var. *cristatum*) as examples; they were large plants when found, and must have had millions of spores carried by the wind in all directions, yet no second plant of either has ever been discovered. When spores of these are sown and carefully tended, the amount of plants raised is only restricted by the number of spores sown.

It must be apparent to every one that in growing such extremely delicate and minute forms of vegetable life, where constant daily care is essentially requisite, we are able in an artificial manner to materially accelerate their reproduction; and that we are enabled to obtain a pedigree of a score generations in fifty years, producing changes in each generation by a series of crossings, whilst in the wild state they will not have changed, or only rarely be changed, from the normal form. From the author's own crossing of Ferns a pedigree of twelve and thirteen generations has resulted since 1860, and the author never now raises a normal form from their spores, every plant is a variety. From time to time changes have branched out from this pedigree in various directions. In 1842 the author began the cultivation of Ferns, in 1880 they were all removed from Nottinghamshire into Monmouthshire, and for

several months were kept in pots within a walled drying ground, and ever since that time varieties of Scolopendriums have kept appearing on neighbouring walls, where before there was nothing but normal forms. One of these Scolopendriums (*Lentonense*) has been found three-quarters of a mile off, no doubt from spores carried by the wind from the original plant.

We are not only entitled to ask why certain results are produced from certain experiments, but also to accept the most natural explanation. In the case in point, the production of the four characters of four Fern parents on one and the same seedling was obtained by mixing spores of the four varieties; not as a solitary instance, but repeated over and over again for a number of years, the repetition giving evidence of the same result, and, even when varying the experiments in every possible manner, this fact remains unaltered. May we not think the established law *that only one sperm acts on the same germ* does not hold good with Ferns, for if it did we could not obtain the combination of more than the peculiarities of one male and one female. If we consider the effect of the combination of four parents (now proved in so large a number of instances), we must believe the result can only have been from the fertilisation of the ovum or ova *on one and the same prothallus.* There must have been the influence of three sperms from three different prothalli with one ovum; or a sperm from three different prothalli must have fertilised three different ova; and these being *on the same prothallus*, assimilation may have caused the whole of these fruitful cells to fuse, as it were, the sperm characters, and thus produce a plant having the forms of all the sperms; or, what is as likely, a number of sperms have assisted in this impregnation. In the case of assimilation,* the characters of the germ will predominate, because there

* A term the author has adopted to denote the *fusing* of the inflorescence of the sperms of two or more fertilised germs on the same prothallus.

will be the influence of three germs, with the same peculiarities, combining with three different sperms, each having its own character.

Turning to the experiment of an equal amount of spores of two varieties, when sown together, giving the characters of both in all the progeny, instead of a portion only having the character of one variety, allusion is here made to the experiment with a *normal* and a *crested* variety, where in a thousand seedlings only three were normal, or in proportion of 333 to 1. Were a single sperm only to act on a single germ, we should naturally expect two hundred and fifty plants like the normal variety, and two hundred and fifty like the crested one. Two hundred and fifty would be the crested crossed with the normal, and two hundred and fifty the normal form crossed with the crested; this would give seven hundred and fifty with crests, and two hundred and fifty without, which is a strikingly different proportion, being as three to one.

If this impregnation were extended to more cells, and assimilation admitted, it would be possible to account for even greater variations; but this does not explain the result if two varieties alone are sown together. No one can deny the fact that the peculiarities of three or more varieties have been produced by one and the same impregnation (the plants unmistakably show this); but as to whether this has resulted from the action of more than one sperm on one germ, or of more than one germ on a prothallus, being each fertilised by a single sperm, or a number of sperms acting on several germs on the same prothallus, assimilating and imparting all their peculiarities to one of these germs, the conclusion arrived at must in any case be in opposition to the assertion that only one sperm can act on a germ. And this seems to hold good as regards the pollen of flowers, as is shown by a repetition of the experiments on single dahlias. In crossing a white with a red dahlia very few of the seedlings were

white (in two of the trials none were white), with equal parts of pollen (red and white); using two parts of white pollen to one of red did not appreciably alter the result—though crossed with a white flower very few were white; but with six parts white to one of red a large proportion of white seedlings was raised. When this single dahlia was first introduced, Professor Lawson (then director of the Oxford Botanic Gardens) gave Mr. Joseph Sidebotham, of Manchester, seeds which produced both white and red flowers. Mr. Sidebotham presented to the author seeds of the white variety (called *Stella bianca*), but they did not produce even one white seedling. In the following year the author had a division of the white variety, and, whilst isolated, the whole of its seedlings were white. Bees fly from flower to flower, and thus the pollen becomes mixed; but if only one sperm effected impregnation, we should raise white flowering seedlings abundantly.

There appears no doubt that when impregnation has taken place no second contact of pollen will have any effect; care is only required so as to be enabled to accomplish the first contact; after this, insects cannot produce any change.

It requires isolation to raise plants like the parent. If we instance the white variety of *Agrostemma coronaria*, under these circumstances the seedlings will be white. *Aquilegia glandulosa*, if away from all other Aquilegias, will produce plants like the parent; but if the English *Aquilegia vulgaris* is near, a combination results, and in two or three years there will not be a single plant raised that is true *Aquilegia glandulosa*. It is the same with other plants that freely cross. From this cause it is now difficult to raise true plants of *Cupressus Lawsoniana*. *Papaver alpina* growing near *Papaver nudicaule* is soon lost, and a mixture of the two becomes established. This was known years ago both by Mr. Henderson, of Wentworth, and Mr. Elworthy, of Nettlecombe Court, and both kept *Papaver alpina* isolated, and thus preserved

this plant. Impregnation of a single germ by a single sperm would give us a proportion of plants like the seed-bearer for a lengthened period, instead of losing the true species in two or three years when not isolated.

If this new fact, owing to insurmountable difficulties, has not been seen by miscroscopical examination, the experiments have demonstrated it mathematically; for, if we get the combination of four varieties at once, it must prove that a single combination of any two of these could not produce this result: $\alpha + \beta$ could only form $\alpha\beta$, not $\alpha\beta\gamma\delta$. The mixture of blue and yellow can only be green.

DETAILS OF EXPERIMENTS.

Altogether, in the forty years, more than nine hundred experimental sowings of spores have been made, and from these the following have been selected as illustrations of more than ordinary interesting results.

These experiments increased gradually; they were few at first, but increased enormously when the fact of multiple parentage gained credence. In one year they exceeded a hundred, and from 1887 to 1892 nearly five hundred different combinations of mixed spores were being carefully watched.

Occasionally the spores have either not germinated or have been afterwards destroyed either by confervoid growth or by want or excess of water. Altogether this destruction has been on a very limited scale. Dr. Fox was several times extremely unlucky, even to failing with the whole sowings of a year.

By always sowing each combination in three or more pans, and using different soils, there is not much chance of failure. Germination varies materially as regards time on different soils; it is quickest on the damp loam of a reversed

grass sod, and very slow on a peat surface. There is a disadvantage, however, in the sod, as it is more apt to have confervoid growth than is the case with peat.

Mr. Harris, at the Clifton Zoological Gardens, is very successful; he uses large pans, and has a very coarse material of leaf, loam, and broken crocks; under a sheet of glass this retains a sufficient amount of moisture for a long period. For sowing very thickly (and this is the only way to produce compound impregnation) the author prefers a more even surface.

EXPERIMENT NO. I.

In 1866 the following varieties of *Adiantum Capillus-Veneris* were sown together — *magnificum*, *incisum-Footii*, *Hookeri*,

Fig. 7.—*Clorinda*. Portion of frond.

rotundatum, and *Padleyi*, and amongst the seedlings raised are *Clorinda* (Fig. 7), *nobile*, *Lowæ*, and *admirabile* (Fig. 8). *Clorinda* shows the characters of *Padleyi* and *incisum-Footii*, and *admirabile* that of *incisum-Footii* and *Hookeri*; *Lowæ* more nearly resembles *Padleyi* in its slender pinnules, but is nearly two feet in length, and the fronds are not concave as in *Padleyi*; *nobile* is a modified form of *admirabile*. This same

mixture was again sown in 1868, and similar forms to *Clorinda* and *admirabile* were again raised, and in addition the varieties *kalon* (Fig. 9) and *optandum* (Fig. 10). *Kalon* has the characters of *incisum-Footii*, *Padleyi*, *magnificum*, and *rotun-*

Fig. 8.—*Admirabile.*

datum, whilst *optandum* shows the characters of *Hookeri* and *rotundatum*.

In 1872 a third sowing of varieties of *Adiantum Capillus-Veneris* consisted of *magnificum*, *incisum-Footii*, and *Lowæ*; from these a seedling was raised named *Sibyl* (Fig. 11), which

has the incised character of *incisum-Footii*, and the large pinnules of *magnificum* with the habit of *Farleyense*. A seedling raised from *Sibyl* at Nettlecombe Court is identical with this. Besides *Sibyl*, the author raised in the same batch of seedlings *autumnale* and *luminare*, two varieties that are not unlike *nobile*, the one having an erect habit, and the other dependent fronds, while both have autumnal golden tints.

Fig. 9.—*Kalon*. Basal pinna.

In 1882 a fourth sowing, consisting of the varieties *Daphnites*, *fissum*, and *cornubiense*, gave no seedlings of importance; only about thirty grew to maturity, and most of these were copies either of *Daphnites* or of *fissum*, and only three showed the characters of *cornubiense*.

EXPERIMENT NO. II.

In 1870 five varieties of *Asplenium marinum* were sown together, *i.e.*, *capitatum*, *caudatum*, *ramo-trapeziforme*, *paral-*

lelum, and *ramosum*; from this mixture the following have been raised, *ramo-capitatum* (a very good ramose form—Fig. 12),

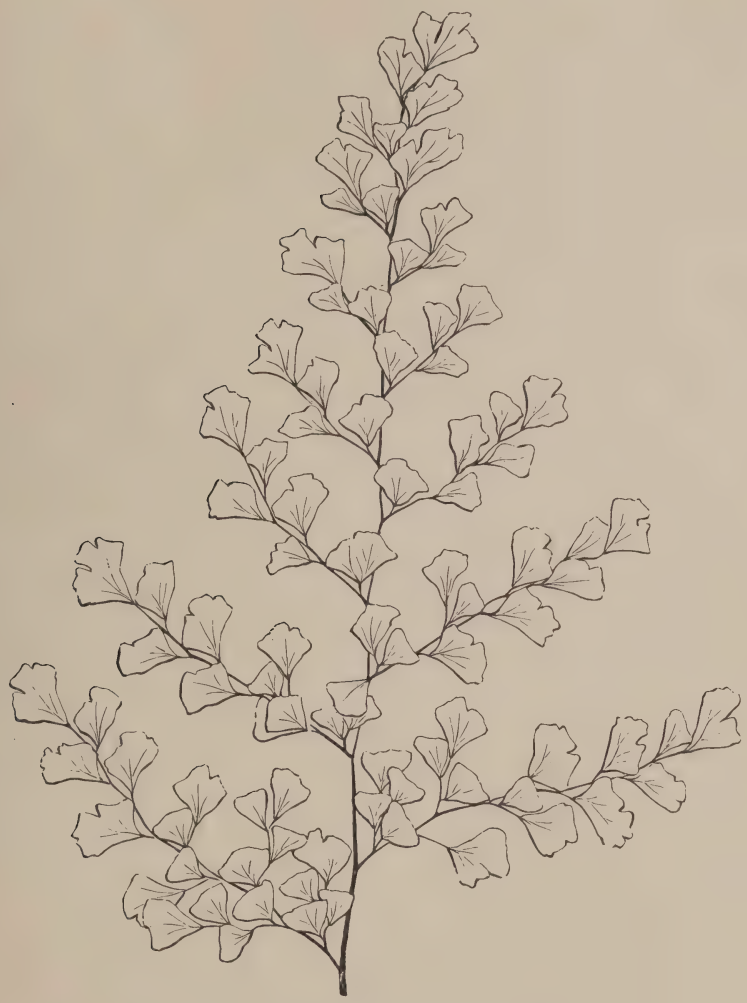


Fig. 10.—*Optandum*. Upper half of frond.

ramosum Lowei, a stronger grower than *ramosum*, and *admirabile*, a somewhat depauperate variety with narrow pinnæ.

In 1879 the same varieties were again sown together, and amongst the seedlings are *nitens* (a very varnished-looking

variety); *optandum* (Fig. 14), having confluent irregular pinnæ, with no two alike either in form or in the incised margin; and *multifido-irregulare* (Fig. 13), with unequal-sized pinnæ, some of great length, and others less than the lobes of the larger pinnæ—in this variety the apex of the frond is branched. Mr. Clapham, of Scarborough, and Mr. Monkman, of Malton, raised varieties that in some respects were similar to *multifido-irregulare*, and the former raised one almost

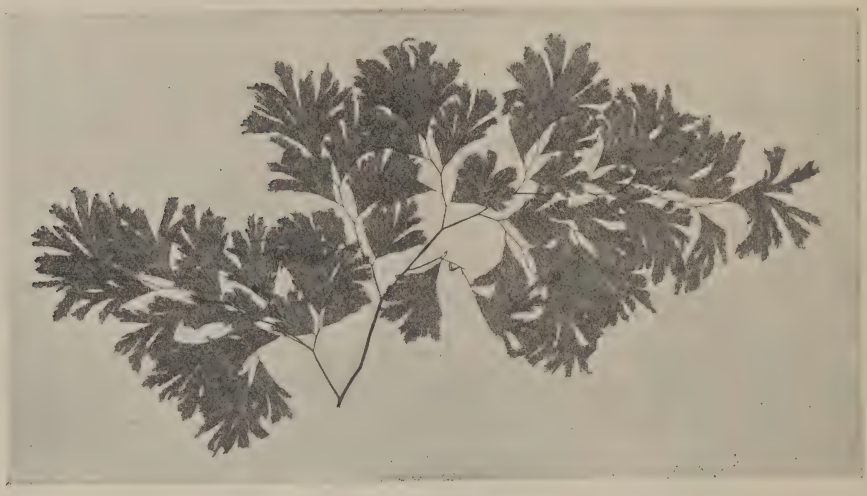


Fig. 11.—*Sibyl.* Much reduced. (See page 76.)

identical from a mixture of *trapeziforme* and *ramosum* added to *parallelum*.

In 1882 the author repeated these experiments of 1870 and 1879, and raised *Ella* having long, broad pinnæ, crenate from the base, the lowest pinnæ being broadly auriculate. The apex of the frond is bluntly caudate, if such an expression may be used. The fronds are 11 inches long and 3 inches broad. *Kathleen* was raised at the same time; this is a smooth strap-shaped variety, having an acute-pointed frond, ending suddenly. The pinnæ are not auriculed, and are subrotund in form.

Fig. 12.—*Ramo-capitatum.* Much reduced.

Fig. 13.—*Multifido-irregulare.* Reduced frond.

Fig. 14.—*Optandum.* Natural size.

Length 12 inches, width 1½ inch. In 1893 Mr. O'Kelly found a variety near Ballyvaughan, that differs in having larger and narrower pinnæ, and in being crenate and caudate.

EXPERIMENT NO. III.

It has been found necessary to refer to this experiment several times, as this was the endeavour to cross two species to obtain a hybrid, and the result is one of botanical interest. Illustrations are inserted with the paper on "Hybrid Ferns" read at Bath. (See page 18, Figs. 1, 2, and 3.)

In 1875 the spores of *Aspidium angulare* var. *Wakelyanum* (a narrow strap-shaped cruciate variety) and *Aspidium aculeatum* var. *densum* (a short fronded form with crowded pinnæ) were sown together to produce a hybrid. It was thought that if a cruciate *Aspidium aculeatum* could be obtained, this would be a convincing proof that the cross had been acquired, as previously a cruciate variety of *Aspidium aculeatum* was unknown. These plants came to maturity in 1882; the number of seedlings slightly exceeded 1000, but all except five were close copies of *Aspidium aculeatum* var. *densum*, or of *Aspidium angulare* var. *Wakelyanum;* these five hybrids had all the characters of *Aspidium aculeatum* (in the stronger consistency of the pinnæ, and richer and deeper colour), but not only this, they were a copy of the cruciate variety *Wakelyanum*. This experiment was repeated in 1885; there was a less number of seedlings (about 200), but amongst them was a solitary strap-shaped cruciate *Aspidium aculeatum*, rather more robust than the five of the former experiment.

When young, these hybrids did not show any cruciate character, but they gradually became narrower as they increased in the length of the frond, until on the seventh year they were perfectly cruciate. The plant of the second experiment is now eight years old, is as yet only partially cruciate,

and will require another year to enable it to wholly assume the character.

We have in this experiment the singular fact, that instead of raising plants with characters half-way between the two, there is an exact reproduction of the cruciate character of the *Aspidium angulare* transferred to the *Aspidium aculeatum.*

The great disparity in the numbers, and the strong resemblance to one or other of the parents in all but five of the seedlings, point to the difficulty of producing hybrids, and explains why it is we do not find more of them.

These hybrids are copiously soriferous, and the spores appear as naturally formed as in any other Ferns, but they are mostly sterile, as only one in many thousands can be made to germinate. In ten years the author sowed one hundred pans with these spores, and as they were sown thickly it is an under-estimation to say there were one hundred thousand, yet not a single plant was raised. The same ill luck attended Mr. Clapham of Scarborough, Mr. Clift of Birmingham, Mr. Sang of Kirkcaldy, Messrs. Stansfield of Sale, Major Cowburn of Dennel Hill, Mrs. Grant of Hillersdon, Messrs. Pearson of Chilwell, and Messrs. Dickson of Chester; on the other hand, the thousands of spores persistently sown by Mr. Carbonell of Usk yielded nine plants; those by Mr. E. F. Fox of Bristol, four plants; those by Colonel Jones of Clifton, one plant; whilst those by Mr. Barnes of Milnthorpe produced from thirty to forty—the amount cannot be told exactly, as most of them were returned to Colonel Jones whilst in a young state and dispersed amongst friends. Twelve were sent to me, and now they have arrived at maturity only five of them turn out to be *Aspidium aculeatum,* whilst there are only two at the Clifton Zoological Gardens. At the utmost Mr. Barnes could not have raised above ten that were true *Aspidium aculeatum,* and he must have sown above a hundred thousand spores;

altogether, at least a million spores were sown to produce less than thirty plants of this hybrid, or, roughly, one in four thousand, and this is all but sterility.

These twenty to thirty children of the hybrid are also copiously soriferous, and they differ inasmuch as *their spores* germinate freely.

EXPERIMENT NO. IV.

This is of interest, as it convinced Mr. Clapham, in 1879, that it was an undoubted proof that Ferns could be crossed. He had expressed himself up to this time as unconvinced, although he had seen many of the crosses claimed by the author from time to time for nearly twenty years.

In 1875 two Lady Ferns, *Victoriæ* and *proteoides*, were sown together; both are cruciate, *Victoriæ* having narrow lax crested pinnæ, whilst *proteoides* has bold short dense uncrested pinnæ, unequal in length, some projecting far beyond the others.

In 1879 the seedlings had become mature, showing a complete gradation, having *Victoriæ* at the one extreme and *proteoides* at the other.

Mr. Clapham saw fronds from twenty-seven of the seedlings. There was not a single seedling in the whole batch that was identical either with *Victoriæ* or with *proteoides*. There were plants that had two-thirds more of the character of *Victoriæ* than of *proteoides*, others with those characters reversed, and part where the characters were about equally divided. There were some with only a trace of *Victoriæ*, and others that were a near approach to *proteoides*.

Now had any one sperm impregnated a single germ, a third of the plants would have been a copy of *Victoriæ*, a third that of *proteoides*, and a third having a character midway between the two. There could not have been a gradual series of changes: either a greater or less number

of sperms must have been deposited in one or more germs.*

Illustrations of the parents of these Ferns, in all the experiments, will be found in their proper position in the new edition of "Our Native Ferns," and reference will hereafter be given to their offspring.

It may be added that in 1879 a repetition of this cross gave identical results.

EXPERIMENT NO. V.

In 1883 three varieties of *Aspidium angulare* were sown together: *inæquale* of Padley, *polydactylum* of Jones, and *variegatum* of Moly, half of the mixture by myself, and half by Colonel Jones at the Clifton Zoological Gardens. The *variegatum* is normal except as regards its variegation, and the *inæquale* has normal pinnæ with depauperate pinnules. The seedlings came to maturity in 1887, and, amongst the plants, both Colonel Jones and myself raised an *inæquale* that was both polydactylous and variegated.

To produce these varieties at once could only be done, either by two different sperms acting on a single cell, or by two cells being crossed on the same prothallus, which, by what the author calls assimilation, may have spread the effects through this prothallus. This would not be requisite if we assume that more than one sperm acted on the same cell.

The above experiment brought out an interesting fact, viz., that it is possible to transfer variegation in these crosses.

Moly's *variegatum* sometimes bears fronds that are entirely white, and their spores seem as perfect as possible. Major Cowburn and the author sowed a number of pans with spores of this, in the hope of producing plants with white fronds; neither of us, however, succeeded in raising a single plant.

* If we assume that two or three germs had each been fertilised by only one sperm, there would still be equal proportions of male and female characters.

EXPERIMENT NO. VI.

In 1885 the spores of eight varieties were mixed together, and were sown in a number of seed pans. These were—*multifidum* (crested), *Victoriæ* (cruciate), *uncum* (lax), *Frizellæ* (lunulate), *truncatum* (truncate), *proteoides* (a cruciate with projecting pinnæ), *crucipinnulum* (cruciate in the pinnules), and *ramosum* (branched). The seedlings became fully grown in 1887, and proved a very interesting collection. They were planted separately; immediately the first frondlets began to appear. Amongst them there was one showing three frondlets, which when magnified were found to be springing up on one and the same prothallus (Fig. 15). This was specially labelled and placed under a bell glass. In a few weeks there was strength enough for division, and by the aid of a penknife they were divided into three plants. All grew, and when they had attained maturity they proved a very extraordinary variety, and were all exactly alike, perfectly dissimilar to any other previously raised.

Fig. 15.—Magnified.

There were two kinds of fronds—one with an attenuated apex, and the other truncate. These fronds between them contained the characters of six out of the eight varieties sown together, with an occasional branched frond that increased this number to seven. The characters were not all combined, the variations taking place in different parts of the fronds.

The remarkable characters of this variety, and the additional fact that all the three plants were alike, showed that all must have been developed on one prothallus, that is, three cells must have been impregnated, and also that more than one sperm had entered these cells.

Here we have three plants exactly alike (Figs. 16 and 17), each having the characters of seven out of the eight

plants sown together. It is more than five thousand to one

Fig. 16.—Truncate form. Fig. 17.—Acuminate form.
Adulterum, the two forms of fronds. Much reduced.

against the production of these seven characters, whilst the pro-

duction of three such plants very much increases these odds; other seedlings in the same batch had the characters of three

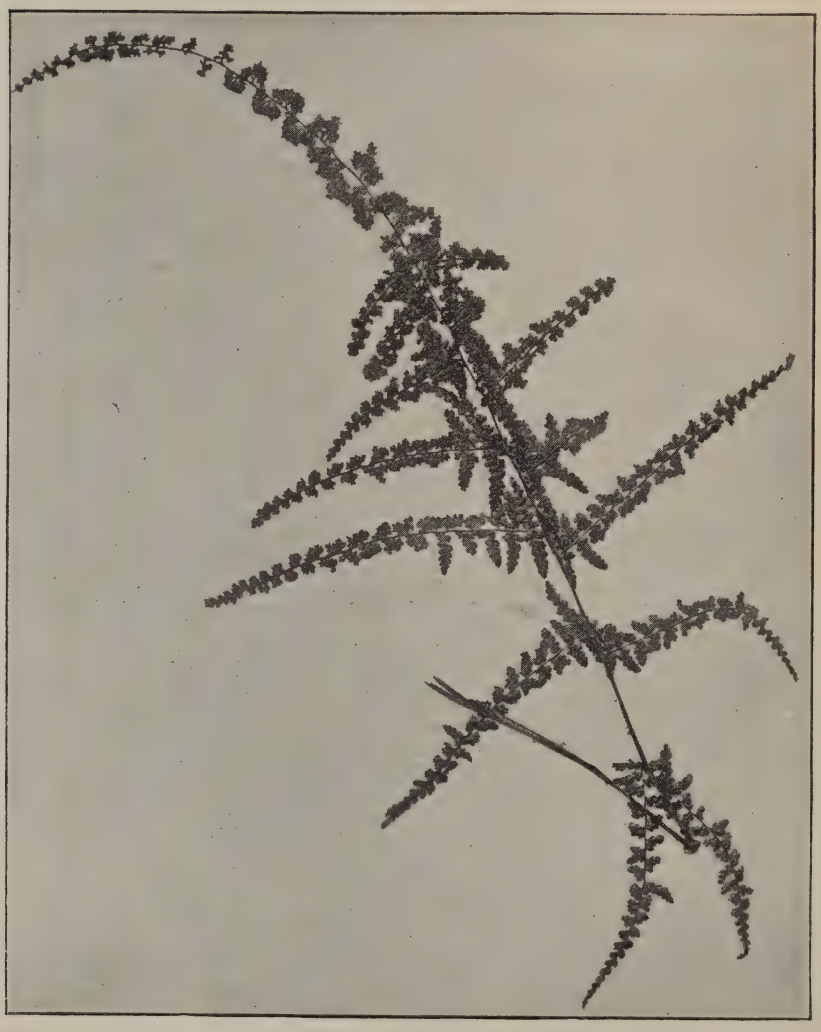


Fig. 18.*—*Adonis*, a seedling from *adulterum*. Much reduced.

and four of the Ferns from which the spores were gathered; on subsequent occasions the author has divided prothalli and produced two plants alike from the same prothallus.

* Fig. 18 illustrates the next generation.

Fig. 19.—*Crispum-latum.*

Fig. 20.—*Keratoides.*

Fig. 21.—*Muricatum.*

All reduced.

EXPERIMENT NO. VII.

Aspidium angulare, vars. *decompositum splendens*, *acutilobum*, *polydactylum*, and *plumosum superbum*, were sown together, with the idea of increasing the plumose character. These spores were sown in 1887, and have been seven years developing into their varietal characters. There are forty-two seedlings, and amongst them are perhaps some of the best British Ferns yet raised. The fronds vary in form from triangular to almost strap-shaped; the following are distinct:—

Ampella	acutælobed, and the apex pointed.
Athene	ostrich-plume-like.
Cadwallon	acutælobed and lax.
Cymbeline	horizontal habit, much imbricated.
Empress	a well-crested plumoso-divisilobum.
Freia	imbricate and very broad.
Ishtar	cuneate and pointed, and imbricate.
Isidore	nearly erect fronds.
Sita	acutilobe, imbricate, and broad.
The Peri	much imbricated.

This list might be extended, as there are other interesting varieties.

EXPERIMENT NO. VIII.

In 1890 *Asplenium Filix-fœmina* vars. *Howardæ*, *Frizellæ*, *Harrisæ*, and *brachiatum* were sown together. *Howardæ* has a normal outline, but with the pinnæ branching irregularly; *Frizellæ* is linear, with lunulate pinnæ; *Harrisæ*, lax, slightly crested, and pinnules revolved; and *brachiatum* has brachiate pinnules. A large number of distinct forms resulted from this sowing, four of which have been selected, and two are illustrated —*i.e.*, *Ariel*, which is irregularly branched and depauperate, with here and there brachiate pinnules; *Carita*, depauperate, lunulate, pinnæ dependent, some of the basal pinnules brachiate,

and some of the pinnæ near the apex of the frond have *Howardæ* branches; *Fama* (Fig. 22), pinnæ branches like

Fig. 22.—*Athyrium Filix-fœmina Fama.* Reduced.

Howardæ, pinnules revolved like *Harrisæ*, lobes of pinnules lunulate like *Frizellæ*, and basal pinnules brachiate like *brachiatum*, the pinnæ distant, and their apices as well as

the frond bifid; *Caterina* (Fig. 23), narrow, showing the influence of *Frizellæ* to reduce the width of the frond, branching in the peculiar manner of *Howardæ*, revolved pinnules as in *Harrisæ*, and brachiate, depauperate, or naked, the upper portion most depauperated.

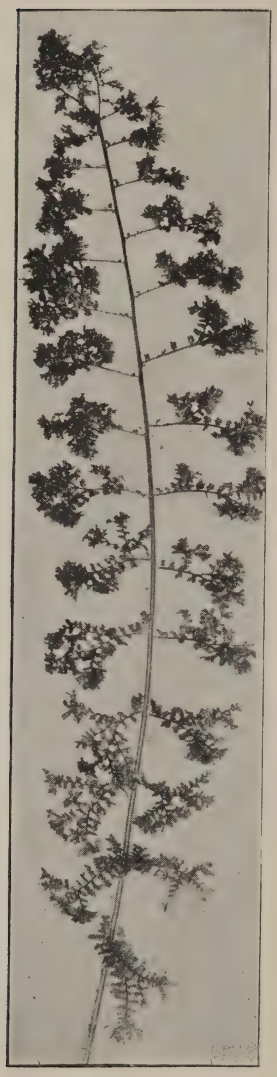


Fig. 23.—*Athyrium Filix-fœmina Caterina.* Much reduced.

EXPERIMENT NO. IX.

In 1888 the spores from three varieties of *Scolopendrium vulgare* were sown together, viz., *crispum-latum* (a handsome *crispum*), *muricatum* (muricate), and *keratoides* (a branching form). (See Figs. 19, 20, 21.) *Crispum-latum* is mostly sterile, and this was the only instance in which the author was able to gather spores, and these were only sparingly scattered on a solitary frond.

The seedlings became mature in 1891, and amongst them were three muricate *crispums*, one of which was branched at the apex in the manner of *keratoides* (Fig. 24). The great interest attached to this experiment consists in the fact that these were the first muricate *crispums* that had ever been raised. Like *crispum-latum*, they have as yet been sterile. Here again, how could a branched muricate *crispum* have been raised without a multiple action of sperms?

EXPERIMENT NO. X.

In 1888 spores of a crested *Nephrodium paleaceum* (*cristatum*) were sown with a non-crested *Nephrodium abbreviatum*

(*Cronkleyense*). The plants were mature in 1891. Three of

Fig. 24.—*Gerda.* Reduced.

the seedlings are crested *Cronkleyense.* There were several hundred plants, yet the whole of the remainder were *Ne-*

phrodium paleaceum var. *cristatum*; there was not a solitary plant uncrested. As yet the author has failed to raise any seedlings from these crested seedling plants of *N. abbreviatum*. This is evidence that *Nephrodium paleaceum* is a species distinct from *Nephrodium abbreviatum*, thus confirming Mr. Wollaston's views.

We have in this experiment another proof that it requires more than one sperm to effect impregnation, or some of the seedlings would have been without crests.

EXPERIMENT NO. XI.

In 1888 four distinct varieties of *Scolopendrium vulgare* were sown together—*undulatum* (a wavy fronded Fern), *spirale* (a dwarf variety with a spirally twisted apex), *muricatum* (a muricate form), and *keratoides* (a branching crested form). (Figs. 20, 21, 25, 26.) These became mature in 1891: all the seedlings are more congested than *undulatum*. There are between two and three hundred plants, out of which four unmistakably show the character of all the four parents, and have received the names of *Darwiniana*, *Psyche*, *Blossie*, and *quadriparens*:* they are distinct, but all are undulate, muricate, branch-crested, the crestings being spirally twisted. The author's son photographed these in 1892; they are now larger.

The greater number in this experiment show the characters of only two parents, a diminished although a considerable number those of three, and only four those of all the four parents. There are none showing the characters of only one parent. A few are much congested, being only an inch or two in height; they are undulate and twisted in a ball-like manner. In 1891 thirteen of these plants were exhibited at the Royal Horticultural Society, and although

* See Figs. 27, 28, 29, and 30.

the Society hesitated to endorse multiple parentage, still the

Fig. 27.—*Darwinianum.**

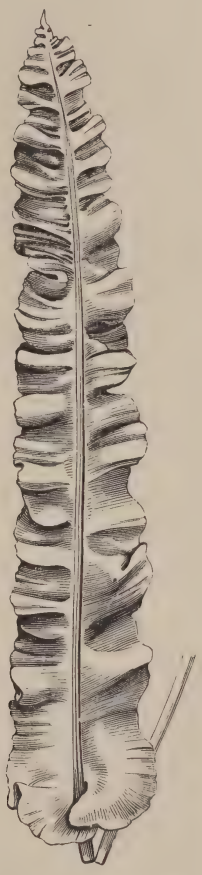


Fig. 25.—*Undulatum.*

Fig. 29.—*Blossie.**

Fig. 28.—*Psyche.**

Fig. 26.—*Spirale.*

Fig. 30.—*Quadriparens.**

* All the above are reduced. The photograph has failed to show the muricate character of Figs. 27 to 30.

plants had shown so much prima-facie evidence as regards their multiple parentage that a Silver Floral Medal was awarded.

From the illustrations the author cannot think that any one will doubt that all four characters have been reproduced. This is one of the strongest evidences that all the four parents have participated in their production.

It may be mentioned that although we produce the combination of three or four varietal forms, none are alike, most very dissimilar, a proof that the number of sperms varies.

EXPERIMENT NO. XII.

In 1888 five varieties of Scolopendriums were sown together, viz., *undulatum*, *muricatum*, *keratoides*, *spirale* (Figs. 20, 21, 25, 26), and *kraspedoumenon* (Fig. 31) (with a ridge near the margin, occasionally having a forked apex). These came to maturity in 1891.

Two of the seedlings are figured. One of these, *Angela* (Fig. 32), shows the characters of all five parents, being undulate, muricate, marginate, and capitate, with twisted divisions; the other (Fig. 33) is only muricate with twisted undulations, and slight crest (the characters of four parents).

Four of the parents are illustrations to Experiment No. 7; the fifth, *i.e.*, *kraspedoumenon* (Fig. 31), is represented here together with two of seedlings named *Angela* and *Hydra* (Figs. 32 and 33).

Multiple parentage is very apparent.

EXPERIMENT NO. XIII.

At the same time as spores were sown in Experiments Nos. 7 and 8, separate pans were sown as follows with four of the varieties used in Experiment No. 7:—

A1 *undulatum* sown separately.
A2 *muricatum* id.

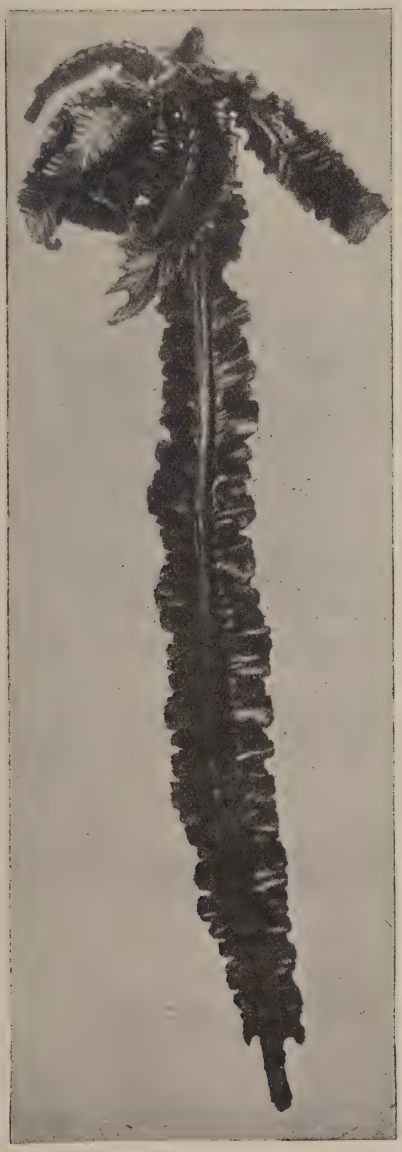


Fig. 32.—*Angela.*

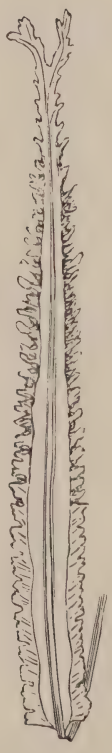


Fig. 31.—*Kraspedoumenon.*

Fig. 33.—*Hydra.*

All reduced.

A3 *spirale* sown separately.
A4 *keratoides* id.

B. *undulatum* mixed with *spirale*.
C. ,, ,, *muricatum*.
D. ,, ,, *keratoides*.
E. *spirale* ,, *muricatum*.
F. ,, ,, *keratoides*.
G. *muricatum* ,, *keratoides*.
H. *undulatum* ,, *spirale* and *keratoides*.
I. ,, ,, *muricatum* and *keratoides*.
K. *spirale* ,, *muricatum* and *keratoides*.

This was to thoroughly test Experiment No. 7.

In the pans A1, A2, and A3, the seedlings were exactly like the parents of those sown. A4 varied slightly between *keratoides* and *Victoriæ* (the latter was the parent of *keratoides*).

In the next six pans, from B. to G., two of the varieties were sown together, and at least a thousand plants were produced. They were all *combinations* of those sown in the same pan, and no single one was exactly like either of the parents: indeed it is very rarely that when two are sown together (except they are different species) a plant is raised that has evidently been solely crossed by the same variety; and this, in the author's opinion, is one of the strongest points as regards multiple sperms.

In the three pans H., I., K. were the combinations of three varieties: most of the seedlings were only combinations of two, a very few were combinations of three, and none were like any one of the parents.

Why do we not find seedlings like those in the pans marked A.? Simply because a multiple of sperms is requisite to effect impregnation.

Singularly enough, Professor Vines, of the Oxford Botanic Gardens, suggested that the author should make the above experiments, without knowing that this had been done four years previously.

MRS. COWBURN. VIVA.

VARIEGATED VARIETIES OF SCOLOPENDRIUM VULGARE.

EXPERIMENT NO. XIV.

In 1889 three varieties of *Scolopendrium vulgare* were selected, viz., *crispum* (a plumose form), *digitatum* (finger-crested), and *variegatum* (normal but variegated), the object being to obtain variegated varieties.

The seedlings came to maturity in 1891, and consisted of fifty-one plants: half of these were variegated, one only being a normal variegated one, and this was unlike the variegations from which spores were sown. Most were a combination of two forms thereof, some were of all three. The *crispum* used was *Cowburni*, and one of the seedlings is a variegated copy which has been named *Mrs. Cowburn*, and was thought worthy of a First-Class Certificate at the Royal Horticultural Society's Fern Show in 1892, and also won the Bronze Banksian Medal as the best variegated Fern. A very successful batch of seedlings.

This and two others, *Addie* and *Viva*, are three of the examples. (See coloured plate.)

EXPERIMENT NO. XV.

In 1889, to the three forms of *Scolopendrium vulgare*, *kraspedoumenon*, *keratoides*, and *muricatum*, was added *sinum*, having a cup-like pocket at the apex of the frond; the seedlings are just come to maturity, and are a most extraordinary series of varieties.

The object wished was to produce branching varieties having the cup-like appendage on each branch, this being a desideratum. Several of the seedlings are muricate and branched, having this pocket on each branch. Some of the *peraferens* varieties are cornute; and in this collection of

seedlings there are a number that have converted this cup into a thick muricate one, of more than an inch in length; and in others the murications across the surface of the fronds are minutely cupped, whilst others have in addition a marginal ridge. In some, instead of a cup, there is a rugose rosette.

It is thought desirable to defer illustration, as this may eventually add another link in the chain as regards multiple parentage.

Roughly it may be said that when six varieties are sown together, one plant in a thousand will show all the six characters; with four varieties, about one in two hundred; with three, one in fifty; whilst with two, not less than nine hundred and fifty in a thousand.

EXPERIMENT NO. XVI.

In 1889 spores of the *Asplenium Ceterach* were sown with those of the *Ceterach aureum* of Madeira, a representative of our English Ceterach on a gigantic scale; these are now of mature size, having much larger fronds than the English species, yet much smaller than those of the Madeira form.

The author has said that hybrids are all but sterile, and as these seedlings yield young plants as freely as the ordinary *Asplenium Ceterach*, we are prepared to assert that the two are forms of the same species.*

As a caution to those who feel an inclination to repeat any of these experiments, the author adds that the spores must all germinate, or, rather, the prothalli must arrive at maturity at the same time, or a cross will not be obtained.

Spores sown after being kept months or years take a far longer time to germinate; it is therefore obvious that

* For illustrations refer to *Asplenium Ceterach* var. *Kalon*, page 104.

spores from fresh-gathered fronds must not be sown with them.

The experiments made since 1889 are very numerous, and none of the seedlings are as yet fully grown, so that what more there may be to say on this interesting subject with regard to them will be deferred.

Fig. 34.—*Khedive.*

EXPERIMENT NO. XVII.

In 1889 three Ferns were selected and the spores sown together—viz., *Khedive*, a seedling raised from *projectum*, having prominent projections; *Rosabelle*, a seedling raised from *Cœlestinum* (a narrow fimbriated form); and *corale*, a

seedling *crispum* raised at Shirenewton. The combination of these three (Figs. 34, 35, and 36) has produced *Desirée*, (Fig. 37), which conclusively shows the projections of *Khedive*, the *crispum* character of *corale*, and the fimbriated margin of *Rosabelle*.

None of the experiments show multiple parentage more

Fig. 35.—*Corale.*

Fig. 36.—*Rosabelle.*

plainly than this. There are two thousand seedlings, among which nine are more or less like *Desirée*, though differing in several respects; and amongst the remainder are other curious forms. Although the characters of the seedlings are conspicuous, another year's growth will add stature and further developments of these characters.

Another variety raised from the same batch of seedlings,

Fig. 37.—*Desirée.*

and named *Elaine*, is 14 inches by 1½ inch, except where

there are projections, when the width is $3\frac{1}{2}$ inches. The margin is well fimbriated and crisp, and the apex of the frond is slightly crested.

EXPERIMENT NO. XVIII.

The fourth experiment explains the raising of three plants from one prothallus of an *Asplenium Filix-fœmina*, the variety produced having a number of marked characters that are identical in all three plants. These plants are all now (1894) fully grown, and exhibit their distinctive features in a marked manner, so exactly alike, that they represent what would occur in dividing a fully grown specimen into three plants.

Since this time a prothallus of a *Scolopendrium* has produced three plants exactly alike; the variety is, moreover, quite distinct from any other—it has a broad congested frond of great consistency, which curls back so as to hide a muricate elongated peraferent rosette that is formed at the apex on the under-side; the frond is also muricate, and of a dark green colour, and the habit is perfectly erect; in addition, there rises from the apex of the rosette a thorn-like cornution, which extends an inch above the frond, and this also is warty or muricate. So many combined peculiarities is certain evidence that each had sprung from the same prothallus (see Fig. 38), under the name *Œnone*. Length 5 inches, breadth $1\frac{3}{4}$ inch (the stipes $2\frac{1}{4}$ inches).

This prothallus was one from the mixture of 1889 (Experiment No. 15). It was much smaller, and has taken longer (*i.e.*, five years) to develop than in most cases. It shows the characters of all the varieties except *keratoides*. It, however, varies from the variety *sinum* in substituting a rosette for the peraferentary, like a change, as it were, from a single to a double flower, and this is either caused by

a germ of *keratoides* or of *muricatum;* further experiments will show which, for this rosette-like character has been before obtained when spores from these two varieties have been used.

Fig. 38.—*Œnone.* Half size.

EXPERIMENT NO. XIX.

In 1889 three varieties of *Asplenium Ceterach* were sown together, viz., *multifido-cristatum*, *crenatum*, and the normal *aureum* of the Canary Isles. Amongst the seedlings are *Kalon* (Fig. 40), *Selim* (Fig. 39), *Gwen*, and *Sultana.*

Kalon has some of the characters of *aureum* and *crenatum* combined, and the frond is 8 inches long and $1\frac{1}{4}$ inch

broad. The pinnæ are large, rounded at the apex, and have conspicuous, projecting crenate lobes; these are absent in *aureum*.

Fig. 39.—*Selim.*

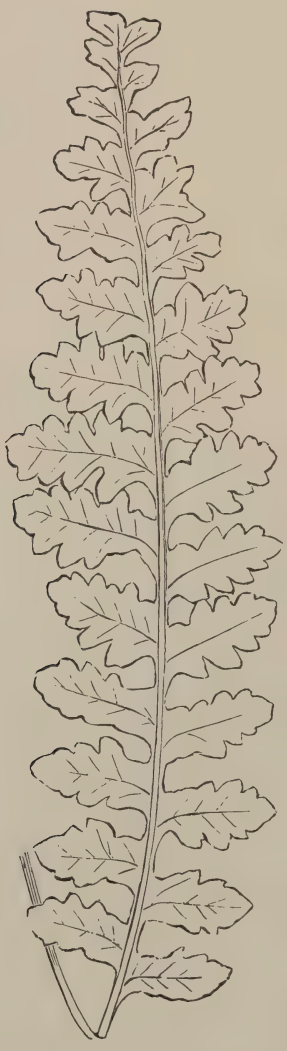


Fig. 40.—*Kalon.*

Gwen is large, has the fronds more lax and the colour darker than in *aureum*.

Selim (Fig. 39). Fronds 3 inches long by half-an-inch

broad; the lobes vary in size; and the rachis divides at two-thirds of the length of the frond, having two and sometimes three branches that are confluent.

Sultana. Fronds 3½ inches long by half-an-inch broad; lobes (sometimes wanting) ovate, and not crenate; and the fronds branch near the apex, the tips being crested.

Fig. 41.—*Astarte.* Half size.

EXPERIMENT NO. XX.

Scolopendrium vulgare vars. *Victoriæ, lineare, omnilacerum,* and *Delesserioides muricatum* were sown together in 1889, resulting in a large number of distinct seedlings. Amongst these are—*Astarte* (Fig. 41); this is a muricate *Victoriæ,* and cut

on the margin in the same manner as *omnilacerum;* and in many parts more or less linear, having characters of all five parents, and below the capitate head like *Delesserioides.* It has a stipes 4 inches long. Length 12 inches, width 1 inch, with a

Fig. 42.—*Zara.* Half size.

branching head 2½ inches wide; colour dark green, and, though muricate, is as if varnished.

Aline is a remarkable variety; stipes only 2 inches, length of frond 9 inches, width the eighth of an inch, rachis with concave marginal belt, sori marginal. The branching head is

very lax, 6 inches wide, and dark green in colour; there are traces of *lineare Victoriæ*.

Planet. Stipes 4 inches, length of frond 11 inches, width a quarter of an inch, colour deep green, a branching apex 5 inches wide.

Eularia. Stipes 4 inches, length of frond 13 inches, width

Fig. 43.—*Paulovna.* Half size.

half-an-inch, colour pale green, a branching apex 7 inches wide. The fronds are weeping from the base of the rachis. The three latter varieties do not show the character of *muricatum.*

Zara (Fig. 42). Another peculiar variety—showing traces of *Victoriæ lineare* and *Delesserioides.*

Paulovna (Fig. 43). A very lax *Victoriæ*-like form with evident peculiarities of *lineare Victoriæ* and *Delleserioides;* the stem is naked, and all the divisions of the capitate apex are linear; sori marginal.

Czarina. Somewhat similar, but with an enormous head, which is pendent.

EXPERIMENT NO. XXI.

In 1890 the following varieties of *Scolopendrium vulgare* were sown together—*kraspedoumenon* (a variety having marginal sori), *lineare* (an exceedingly narrow form having the stipes broader than the leafy portion), and *keratoides* (a branched variety). Many of the seedlings are distinct varieties. *Arline* is the best; it is 9 inches long, and only one-eighth of an inch broad. At 3 inches from the apex the frond expands into a much ramose head, which is 3 inches long and 6 inches wide, with all the divisions linear; and the sori, which is copious both on and below the capitate head, is marginal.

EXPERIMENT NO. XXII.

There are some very curious varieties raised from this 1890 mixture of *Scolopendrium vulgare.* The varieties sown together are *undulatum*, *spirale*, *muricatum*, *cornutum*, and *peraferens.*

Attention may be called to *Puck*, which is undulate, muricate, and has a horn half-an-inch long at the apex of the frond, which is muricate and club-like. Below the horn is a muricate rosette, the divisions of which are at right angles to the horn. The length of the frond is $4\frac{1}{2}$ inches, and the width six-tenths of an inch. The stipes is $2\frac{3}{4}$ inches long. There is evidence of the combination of all five parents in this variety.

A second variety (*Argia*) has an arcuate horn $1\frac{1}{2}$ inch in length rising from a peraferent muricate rosette which is seven-tenths of an inch in diameter. The horn is not muricate. The frond is a naked stipes, except the rosette.

A third (*Libya*) is larger, the fronds being 9 inches long and six-tenths of an inch broad. The stipes is 5 inches long, and the peraferent cup half-an-inch in diameter. The frond is muricate and very rough; the cup is placed at the tip of the frond, and at right angles to it—*i.e.*, the frond terminates in a horizontal cup, out of the centre of which is a muricate horn three-quarters of an inch in length.

Indra. Broad peraferent truncate variety, 6 inches by $2\frac{1}{4}$ inches; the cup $1\frac{1}{2}$ inch wide, the upper part fringed and horned; it is undulate, muricate, peraferent, spiral, and cornute.

Mirza. A narrow rugose peraferent variety, 4 inches by $2\frac{1}{2}$ inches, the stipes being $2\frac{1}{2}$ inches. Below the apex is a small double rosette in the place of the peraferent cup, and it has a stag-like horn which branches, and one of these again branches.

EXPERIMENT NO. XXIII.

In 1890 the spores from four varieties of *Scolopendrium vulgare* were sown together, viz., *crispum*, *muricatum*, *Victoriæ*, and *spirale*, the seedlings from which were very interesting. The following may be quoted:—

Adriana (Fig. 44), whose crisp undulations touch each other, and whose margins of the frills are more fimbriate than any seen by the author. The apex of the frond is blunt, and usually of the same width as the base, and the frills are as much on the under as on the upper portion of the frond, causing the depth to be $2\frac{1}{2}$ inches on a frond $4\frac{1}{2}$ inches long and $2\frac{1}{2}$ inches broad. As yet the plant is small, but it is rapidly increasing in size.

Beda. A muricate *crispum*, dividing at the apex into acute points. Length 8 inches, width $1\frac{1}{2}$ inch.

Cornelia. Crisp and fimbriate, and expanding in the middle of the frond into broad branch-like lobes or leafy divisions.

Length 5 inches, width 1½ inch, the branch-like head 4 inches wide.

Cynthia. Fringed and frilled, the frond somewhat ovate and thin in texture. Muricate near the rachis.

Feodorovna (Fig. 45). Wavy, muricate, and spirally twisted,

Fig. 44.—*Adriana.* Half size.

the murication being confined to either side of the rachis. The frilled divisions branched. Length 5 inches, width 4 inches.

Gyneth. A *crispum* with a thicker consistency of frond than usual; well fringed. Length 7 inches, width 2 inches.

Melitza. A narrow muricate *crispum.* Length 5 inches, width 1¼ inch.

Mermaid. Spirally frilled and reflexed. Half the width of the frond nearest the rachis muricate for the lower half of

Fig. 45.—*Feodorovna.* Half size.

the frond, above which it is muricate to the margin. The apex split into a capitate muricate crest that twists back. The consistency is thicker than is usually the case in the *crispum* forms. The frills are so close together that they overlap. The colour is a rich green. Length 10 inches, of

which the stipes is 2 inches; width 3 inches. In this variety are the characters of all the four parents.

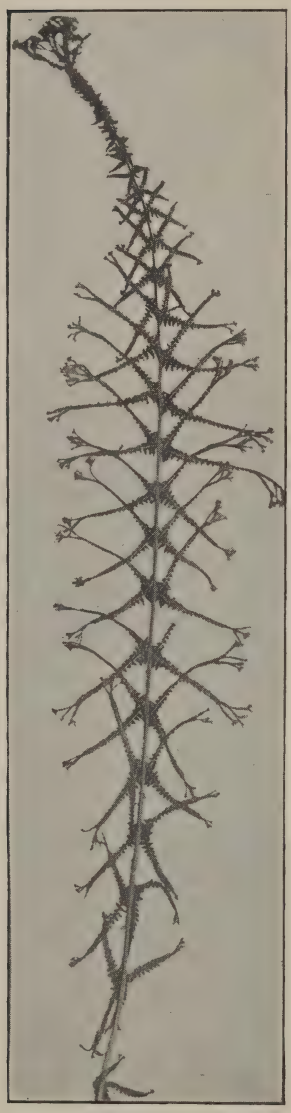


Fig. 46.—*Czarina.*

Ruthella. A very promising *crispum.* Length 6½ inches, width 2 inches.

Zoflora. Frilled and fringed, the frills broad and reflexed, the apex pointed. The lobes at the base are large, well fringed, and fimbriate, and spirally twisted, extending half-an-inch beyond the twisted part of the frond. Length 7½ inches, of which 3 inches is the stipes; breadth 2 inches.

After another year's growth the above will be a great addition to the *crispum* section. There are also forty-two other seedlings, most of which are too small to show their true characters.

EXPERIMENT NO. XXIV.

In 1891 the spores from four well-known varieties of *Asplenium Filix-fœmina* were sown together—*i.e.*, *uncum*, a lax form; *grammicon*, a linear and somewhat lunulate variety; *Harrisæ*, revolved and minutely crested; and *Victoriæ*, cruciate, with a peculiar small crest. The seedlings vary from the width of *Victoriæ* to that of the linear forms. The following are some of the most distinct:—*Cœleste.* The form of *grammicon*, with short *Victoriæ* pinnæ.

Czarina (Fig. 46) has the normal form of *Victoriæ*, yet more lax, and the pinnæ and pinnules linear.

Hortensia. Very lax, with the general characters of *Harrisæ*, especially in the revolved pinnules ; the crest is that of *Victoriæ*.

Fig. 47.—*Kezia*. Reduced.

Fig. 48.—*Tirona*. Reduced.

Fig. 49.—*Thule*. Reduced

Kezia (Fig. 47). Linear, pinnæ linear and approximate, and

short as in *grammicon*, also cruciate; the apical crest like that of *Victoriæ*.

Fig. 50.—*Hebe*. Much reduced.

Thule (Fig. 49). Narrow, lax, with the upper portion linear, and having a *Victoriæ* crest.

Tirona (Fig. 48). Narrow and lax near the base, cruciate and broader about two-thirds of the distance up the frond, then linear, with a *Victoriæ* crest.

There are a number of intermediate forms between the two extremes, many of them, as in all the four figured, having the peculiar apical crest of *Victoriæ*.

Hebe (Fig. 50). This variety differs greatly from the other seedlings. It is much larger, and is more crested and cruciate. The basal half of the frond is exceedingly lax; the pinnæ having large apical crests, and the pinnules cruciate and lunulate; the basal pinnules being brachiate, with crested tips. Higher up there are two or three pairs of pinnæ that are crested and cruciate with revolved lobes; still higher it has a combination of the characters of *grammicon* and *Victoriæ*; and the crested apex is quite a combination of characters—the various terminations of the branches being crested like *Victoriæ*.

EXPERIMENT NO. XXV.

In 1891 spores from four varieties of *Scolopendrium vulgare* were sown together, viz., *undulatum* (wavy), *projectum* (having marginal projections), *sagittatum* (normal, with sagittate base), and *Victoriæ* (with much branched, shining fronds). As soon as the prothalli began to show frondlets, the whole were transplanted singly where they could be easily divided. Amongst these prothalli, one had two frondlets, and this prothallus was divided into four, two divisions of which were as yet frondless. All four grew, and by June 1894 had fronds six inches in length: they are all alike, and a distinct variety showing more or less the characters of all four parents. The fronds are somewhat narrow, shining, with the base shortly but conspicuously sagittate, and the apex capitate; along the margins are numerous pointed projections. The frond is wavy,

but not as much so as in *undulatum*. This variety has been christened *Agneta*.

The present example is the fourth undeniable instance of split prothalli, having the plants of each division exactly alike; therefore it may be assumed that the impregnation of more than one female cell must by assimilation have spread over the whole prothallus, *i.e.*, the effect of the impregnation of the several cells must have affected the whole of the impregnated cells of the prothallus, or all the plants could not have been alike. It may be mentioned that in more than a hundred seedlings raised in this experiment, no other was like *Agneta*.

EXPERIMENT NO. XXVI.

Fig. 51.—*Centaur*. Half size.

In 1891 *Asplenium Trichomanes* var. *Troggyense* was sown with a capitate form (*Troggyense* is incised, and has imbricated pinnæ), the object being to produce an imbricated capitate variety. Most of the seedlings are more or less branched at the apex, but scarcely imbricate: one of the seedlings, however, had the apex slightly imbricate, and the somewhat large ramose head is joined in a confluent mass. This has received the name of *Centaur* (Fig. 51).

EXPERIMENT NO. XXVII.

In 1891 a mixture of the spores of *Scolopendrium vulgare* vars. *marginatum*, *digitatum-crispum*, *muricatum*, *omnilacerum*, and Mr. Moly's crested *projectum* were sown together, and amongst other seedlings are—

Ariel, which is marginate, digitate-crested, slightly muricate, and has marginal projections.

Lolah, slightly muricate, digitate, digitately crested, and has a conspicuous sagittate base and marginal projections.

Mariette (Fig. 52), which is digitate, crisp, and has crested projections.

Fig. 52.—*Mariette*. Half size.

Mithra, digitately crested, crisp, muricate, and has crested projections.

EXPERIMENT NO. XXVIII.

This is the experiment marked No. 11, repeated in 1891, and many of the seedlings are very similar to those before

raised, yet some have a stronger constitution, and are more

Fig. 53.—*Cora*. Half size.

pronounced in their characters; two of them are figured, viz:—

Fig. 54.—*Nina*. Half size.

Cora (Fig. 53), having the characters of all the four

parents, although the branching is scarcely more than an attempt.

Nina (Fig. 54), muricate, undulate, branching, and has spirally twisted lobes.

At the same time spores from *Darwiniana*, *quadriparens*, *Psyche*, and *Blossie* were each sown in separate pans, and

Fig. 55.—*Lorna*. Full size.

the seedlings raised are like the variety sown, with scarcely an exception.

Lorna (Fig. 55), undulate, muricate, with a crested apex of enormous size.

EXPERIMENT NO. XXIX.

Nephrodium Filix-mas. Three of Mr. Moly's distinct varieties were sown together in August 1892: these were

his Osmunda-looking variety, his prominent-veined, and his lax form. The plants are now growing rapidly, and will soon show their permanent characters.

EXPERIMENT NO. XXX.

Asplenium Ceterach. A mixture of the varieties *ramoso-cristatum*, *kalon*, *lineare*, and *aureum* was sown on October 10, 1892, and the seedlings are beginning to show remarkable peculiarities. A repetition of this experiment was made in November 1893, but the seedlings are as yet only emerging from the prothalloid condition.

EXPERIMENT NO. XXXI.

Scolopendrium vulgare. Four varieties were sown together in November 1892, viz., *marginatum*, *erosum*, Mrs. Grant's form of *crispum*, and Mr. Fox's *fimbriatum*. The seedlings are as yet small.

EXPERIMENT NO. XXXII.

Osmunda regalis. This mixture, which consisted of the spores of *grandiceps*, *revolvens*, *interruptum*, and the exotic species *gracile* and *spectabile*, was sown on August 7, 1893, and the seedlings are now producing frondlets.

EXPERIMENT NO. XXXIII.

Scolopendrium vulgare. Ten distinct varieties were sown together on August 31, 1893. The seedlings are as yet in the prothalloid condition.

EXPERIMENT NO. XXXIV.

Lomaria Spicant. Spores of *Aireyi-serratum* were mixed with those of a crested and of a capitate variety, and sown on September 20, 1893. As yet the seedlings are in the prothalloid state.

EXPERIMENT NO. XXXV.

Polypodium vulgare. A mixture of the spores of varieties *Forsteri, bifido-cristatum, trichomanoides, marginatum, ramosum, omnilacerum, semilacerum, brachiatum,* and *Saltii* (caudate) was sown on September 20, 1893. The seedlings are showing character, and there is evidence of multiple parentage and great variety of form.

EXPERIMENT NO. XXXVI.

Nephrodium montanum. Spores of the following varieties were sown together on October 20, 1893, viz., a crested, a linear, a crisp, and a depauperate form. As yet they are in the prothalloid state.

EXPERIMENT NO. XXXVII.

Asplenium marinum. Five varieties were sown together on October 21, 1893, and the seedlings are now showing very varied fronds.

EXPERIMENT NO. XXXVIII.

Aspidium angulare. On September 21, 1893, *lineatum, flabellifolium* (seldom fertile), *revolvens,* and *tæda,* with *hybridum,* were mixed and sown. The seedlings are yet small.

EXPERIMENT NO. XXXIX.

Asplenium Filix-fœmina. A mixture of the following varieties was sown on September 21, 1893—*Victoriæ, abasilobum, reflexum,* a crested *Vernonæ,* and *deficiens.* The plants are as yet quite small.

EXPERIMENT NO. XL.

Scolopendrium vulgare. A mixture of the spores of a capitate, a muricate, a crispum, a variegated crispum, a projectum, a pinnate, and a variegated branched form was

sown on September 21, 1893, and the spores are now passing from the prothalloid to the frond-life condition.

EXPERIMENT NO. XLI.

Nephrodium Filix-mas varieties *cristatum* of Wills, *laxum* of Moly, and *monstrosum* of Stabler; *N. abbreviatum* varieties *gracile, capitatum,* and *erosum;* and *N. paleaceum* varieties *cristatum* and *laxum* were sown together on September 23, 1893, but as yet are small.

EXPERIMENT NO. XLII.

Asplenium Filix-fœmina. The spores of six varieties were mixed and sown on October 13, 1893, and are now progressing rapidly.

EXPERIMENT NO. XLIII.

Nephrodium spinulosum. A crested and a very slender form were sown together on October 13, 1893, and are now germinating.

EXPERIMENT NO. XLIV.

Nephrodium paleaceum var. *cristatum* and *N. abbreviatum* var. *erosum* were sown together on October 23, 1893, and are now germinating.

EXPERIMENT NO. XLV.

Scolopendrium vulgare. A mixture consisting of *quadriparens, spirale, capitatum, muricatum, variegatum,* and a narrow marginate variety was sown on October 27, 1893, and are now producing fronds.

EXPERIMENT NO. XLVI.

Aspidium angulare. Eight varieties were sown together on December 5, 1893, and are now germinating.

EXPERIMENT NO. XLVII.

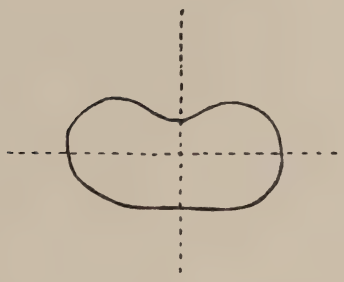


Fig. 56.—The manner in which a prothallus was divided.

Dividing the Prothalli.

Spores were sown thinly in the autumn of 1887,* so as to produce vigorous prothalli that would allow a division into two, three, or four parts. In 1888 a number of these were cut with a sharp knife, some into two, and others into four parts; the experiment was successful, as nearly every division grew, for if divided where there were no rootlets some soon formed when under bell-glasses. Twenty-five prothalli were quartered, and nearly a hundred plants were obtained, but although they grew into sturdy little tufts (much more bush-like than the prothalli that had not been divided), still they bore no fronds, nor did they until these quarters were planted in pairs so as to overlap each other, and then a large proportion formed fronds; those that did not throw up fronds had other divisions planted against them, and by 1892 they could all be potted off as young plants, and a portion had even become mature plants.

* In the experiments made in quartering prothalli in 1887, those recorded as Nos. 16, 20, 29, 31, 312, 316 to 320, 323, 328, 331, 332, 340, and 343 were unmistakably conclusive; and where two plants were seen that apparently sprang from the same prothallus (before being divided), in Nos. 10, 12, 54, 90, 92, and 330 (when they had attained maturity), the plants from the same prothallus in all these six cases were exactly alike. These being repetitions are not further mentioned.

The author has mentioned that some of the quarter divisions of one prothallus were purposely allowed to grow, without putting other divisions to them, in order to ascertain how long they could live in the prothalloid state. All were alive in February 1892 (four years after they had been divided). These four divisions had been planted in a half-pint flower-pot, at the distance of an inch apart, and were kept damp by the use of a bell-glass. They have also been repotted every year. In February 1892 they were unhealthy, and the author determined as they were being repotted to place two of them as closely together as possible, in order to ascertain whether there was any sexual life remaining, and in July three distinct frondlets appeared, which are now strong plants. The two remaining divisions were again repotted in February, and they are now stronger than they were last year. On October 7, 1892, they had been divided four and three-quarter years, and as they had germinated nearly six months before being divided they had then lived more than six years in the prothalloid state.

This experiment proves that the male and female organs are widely separated from each other, and that either male or female organs were on every quarter of the prothallus, but never both on the same. None of these quarters, therefore, were or could be impregnated until a second had been planted in close proximity; and when two quarters, both having only one sex, were placed together, they still remained in the same prothalloid condition, and this could only be ascertained from the circumstance that when other quarters were moved close to them, then these sent up frondlets, and in one instance four plants resulted. It also shows that unless impregnated they can live at all events for seven and a half years, and even then are able to be impregnated and to put on their frond life. It is also another proof that more than one cell can be impregnated.

Altogether these experiments have been remarkably successful, for the different varieties raised were obtained in the identical manner formulated before they had an existence. The anxiety, labour, and attention have been great, and the time occupied has been half a lifetime, but in the success gained there has been ample reward.

On October 15, 1893, one of the two remaining portions of the split prothalli that had been more than six years without putting on frond life at length threw up a frondlet. How this has happened it is impossible to say; there was not another prothallus within several feet of it, and moreover it has always been under a sheet of glass. It can only be conjectured that sperms have by some means been conveyed from a distance (probably clinging to an insect, for a small insect, *Podura plumbea* or skipjack,* was noticed, which might have been there for some time, as the plant had not been examined for three weeks owing to the author's illness). In the hundred examples of split prothalli such impregnation had never before occurred. The prothallus is as healthy now as ever, showing no signs of that decay which is apparent when frondlets form. In its present infantile condition it is not possible to say further than that, like the mother-cell, this is a Scolopendrium. There is, however, in this new fact, proof against those generally conceived views as regards how impregnation of the prothallus takes place. It may be some other method of growth, though the author attributes it to

* It is not only an important fact that the SKIPJACK can convey *sperms* from the *antheridia* to the *archegonia*, and by this means the *oösphere* becomes fertilised, but by placing a skipjack amongst prothalli having only *archegonia*, *i.e.*, female cells, and allowing it to remain there for only twenty-four hours, we are able to ascertain within a few hours when impregnation must have taken place, and by afterwards watching for the appearance of frondlets we can further know the period required between impregnation and the development of fronds. In this instance frondlets were seen on the fourteenth day, but they were certainly two or three days old when detected, therefore this period is probably twelve days.

the skipjack. On April 2, 1894, this portion of a divided prothallus, being in a healthy condition, was for the second time cut into four divisions, three of which are growing vigorously, and now, January 7, 1895, are seven and a half years old and still frondless.

It used to be held that it was impossible for the male organs of a Fern to move from one prothallus to another, as in bursting from the cell they had no projectile force; but as soon as it was acknowledged that Ferns could be crossed, this assumption of inability of the spermoid to travel to another prothallus received its death-blow.

The experiments with regard to dividing the prothallus have disclosed a new method of Fern propagation, for it is easy to multiply the varieties whilst in the prothalloid condition. There is, however, one fact to be ascertained, it is as to how far this can be done, so as to have the organs of generation on each division. If these organs were not present, however much the prothallus might grow, there would never be any fronds produced. In order to test this, the author has cut off two portions of the prothallus that had been in that condition since January 1888; these have been planted under a bell-glass, and are now growing. There would be no uncertainty in a simple division, as it could be so cut as to have the male and female organs on both divisions. Each division of a divided prothallus seems to grow as rapidly as the undivided one, and indeed, since these portions have been cut off, the parent prothallus has itself had an increased luxuriance. Some time ago this prothallus was very sickly, and had the appearance of being in a dying state, but it was repotted, and in two months had become healthy and had doubled its size. The undivided prothallus is more or less of a kidney shape, but, when divided, it throws out a number of extensions in all directions, these numerous folds giving it a more bush-like appearance. Of course it requires skill and patience, as well as experience

and watchfulness, in order to be successful. If the divisions are not made with a sharp penknife, the soil kept at a proper moisture, and any confervoid grown on the surface removed, as well as the bell-glass kept clean, disappointment may result; in short, in the earlier stages a day's neglect might prove fatal.

A prothallus that had been divided into four parts in January 1888, and which, on October 15, 1893 (nearly six years afterwards), had developed a frondlet, after having for all this long period remained in the prothalloid state, was treated in a different manner; that portion of the prothallus on which the frondlet was formed was immediately cut off with a sharp knife and replanted, and this is growing vigorously. The remainder of the prothallus after this separation at once considerably increased its size and strength, so much so that in January 1894 several portions were cut off, and the divisions replanted, and they are now growing. It is still a question as to how long life can be sustained in the prothalloid state. It is now seven years since this prothallus was divided into four portions: two of these developed fronds several years ago; the other two are still in the prothalloid state, though one had produced a frondlet, as before mentioned, on one portion which had been severed from it.

It requires the greatest attention to keep a small prothallus in health: if neglected, and the soil became dry, it would die in a few hours, and if confervoid growth were allowed to grow on the surface of the soil, this would soon destroy it. Having to be kept damp under a bell-glass, conferva will continually appear, unless the surface is moved (with the point of a knife) every few days; then again, young worms get under the glass and throw up mounds of earth, and when this is the case the prothallus has to be repotted in fresh soil that has been previously placed in boiling water, in order to destroy all animal and vegetable life.

In planting the divided portions of a prothallus or prothalli they should always be cut in the same manner, and this is not difficult to accomplish, provided they are not growing thickly together. The upper halves should be kept in one pan, and the lower halves in another, for by this precaution the author has found that no male organs have shown themselves in the former, or female organs in the latter. (Fig. 59, p. 130.)

One of the experiments to test whether the skipjack could impregnate a prothallus may now be described. Portions of prothalli having only female cells were planted in a pan and protected by an inverted wine-glass ; outside this, other portions having only male organs were then planted ; and the whole were enclosed under a tight-fitting bell-glass. Skipjacks were introduced into the outer portion, and a few days afterwards the wine-glass was removed, and the skipjacks allowed to move freely amongst all the prothalli, and several weeks later fronds began to appear. A second pan was planted with prothalli having both male and female organs, though on separate portions ; these were planted half-an-inch apart, and kept covered with a bell-glass for three months, but no fronds were formed ; but after the introduction of the skipjacks, it was soon apparent that impregnation had taken place. It is a striking fact that both the male and female organs have remained in a condition to propagate their species after remaining in the prothalloid state for seven and a half years.

On looking closely into the circumstance of how the spores of four varieties can be made to produce a plant having the characters of all four, it seems that this might be attained by the male organs of three varieties each impregnating a separate cell ; these cells, being on the same prothallus, may by assimilation commingle the characters, and a single sperm in each cell might produce the result ; but this would not produce that graduation of characters which has been so frequently shown—we should not raise plants, some having a slight trace, and others a

pronounced one, of each character. If we suppose a slight trace of any one character to be the result of impregnation by any one sperm, then where the character is more pronounced it is equally fair to assume that this is the result of a number of sperms having that character, and that a varying number of male sperms entering into each cell has been the cause of the various differences.

Taking a deduction of the evolution of sex, it may be stated that the preponderance of the number of males over females seems to hold good both in the animal and vegetable kingdoms. The author has found the proportion of males to females in the yew as 107 to 100, in the aucuba as 123 to 100, in calves as 116 to 100. Statistics show the excess of male over female children. In making any deductions, this excess has to be accounted for. It is only safe to take an average of a series of years, for the numbers differ in different years. Amongst cattle the author has known as many as ten males to one female, and *vice versâ*; also that some years produce many more twin calves than the average; this is well known with sheep.

Having proved that an excess of male pollen from a pink-flowered Dahlia when applied to a single white Dahlia will produce an increase in the number of white seedlings (for we may call the seed-bearer the female), the next step has been the endeavour to find out the true cause of determination of sex. An experiment has been made with a diœcious plant, *i.e.*, having unisexual flowers of the same species that are produced on distinct individuals. In this experiment an excess of pollen has been used in crossing an aucuba, but time will be required to grow the seedlings to maturity. This experiment may enable us to obtain proof as regards the evolution of sex from experimental observation without the aid of the microscope.

Nature assists in overcoming difficulties in various ways, and throughout the vegetable kingdom we are familiar with the help given to certain flowers by insects.

By constant attention to young Ferns in the first stages of their frondlet and frond life, the author became aware in 1887 that when the fronds were under a bell-glass the cooling process at night caused a tiny glittering star to appear at the tips of all the veinlets* (Fig. 57); a close examination showed this to be perspiration through the pores of the veinlets. Gradually the drop became larger, till it slipped on the frond and joined another drop until it finally descended to the base of the frond. Now these same glittering

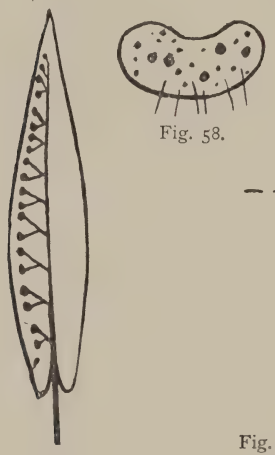


Fig. 57.

Fig. 58.

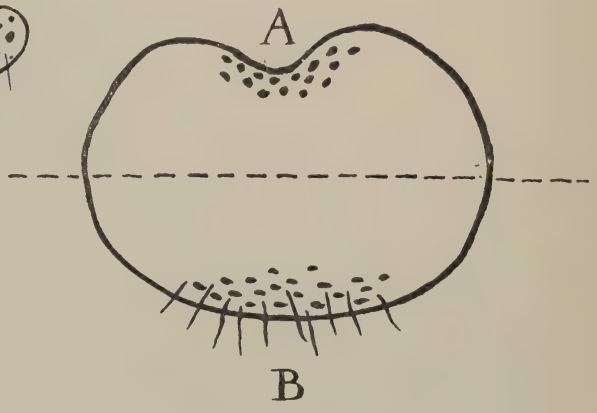


Fig. 59.—Fern Prothallus showing (except in rare cases) the positions of the *Antheridia* (A) and the *Archegonia* (B). The sexes will be on different divisions if the prothallus is cut along the dotted line.

stars were also seen in abundance on the prothalli (Fig. 58), and the fact appeared to be one deserving record. The author sent a report to Professor Bower for insertion in the "Annals of Botany," but before it could be printed it had been announced as a new German discovery. Now this is one means of transporting sperms from one prothallus to another, as drops were seen that bridged over two pro-

* This had a strong resemblance to the star-like glittering of the luminous moss (*Schistostega pinnata*), a minute moss found in the Nottingham sandstone caves, and in much greater abundance on coal shale near Todmorden.

thalli. Other means, however, were also apparent: the tiny offspring of the plant louse, and several other insects, and also minute worms were seen to be constantly moving amongst the prothalli that were covered with a sheet of glass; whilst confervoid growth and minute mosses made a network between one prothallus and another, and these evidences were pointed out by the author at a time when the difficulties to be overcome were reasons given for the sperm being confined to its own prothallus. The question of an occasional submergence of the prothallus by water, which a few drops of rain could accomplish, would be another means; the sperms would float on the surface, and on this flood subsiding would perhaps find themselves deposited on another prothallus. A consideration of these conditions may assist in explaining why wild varieties are comparatively rare.

Instead of a single individual having to give his solitary experience, had not death prematurely put an end to a large number of experiments that were being made by Colonel Jones, Mr. Carbonell, Mr. E. F. Fox, Major Cowburn, Mr. Barnard Hankey, and Mr. Clapham, there would have been added much experience and more confirmatory evidence. With regard to Colonel Jones, all his seedlings came into the author's possession, each experiment being numbered as agreed upon, but unfortunately his book of reference could not be found. Mr. Carbonell's plants went to the Royal Gardens, Kew; but although Mr. Thiselton Dyer, the Director, kindly sent the author Mr. Carbonell's books, there are no notes that are of any practical service, as they are simple references for his own use. Mr. Fox's books were also presented to the author by his daughter; in them every experiment has been carefully recorded, but they have a vast number of useless remarks stating that confervoid growth, &c., had destroyed the seedlings, and in one instance every experiment during a certain year. Major Cowburn had also numbered his

vast collection of pans of seedlings, but his reference-book has not been found. Mr. Barnard Hankey, from ill health, had done but little of late years; and Mr. Clapham, after he left Scarborough for London, had also very much curtailed his investigations.

Although much important information has been so generally lost, there are some very fine varieties coming to maturity. It is a sad fatality that has deprived us of the aid of six very able Pterologists, who were repeating one or other of the author's experiments, and who were also growing a portion of his numerous seedlings. Colonel Jones, Major Cowburn, and Mr. Fox all lived near, and could therefore watch each other's labours and take advantage of each other's ideas.

Another misfortune has curtailed some of the author's experiments, both this year and last, for much illness compelled him to leave the care of the young Ferns to others, sometimes for days, and even weeks; the loss has been less than might be expected, but the delay in re-potting has retarded their growth, and plants that should have come to maturity this year are still (many of them) in their seed pans.

Summarising the evidence of these experiments, an apt illustration of its conclusiveness may be found in the calculations of Mr. Maunder on a perfectly different subject.

Mr. Maunder has pointed out that "during the last nineteen years the three pre-eminent magnetic storms have been associated with the appearance of the three greatest spot groups of that period, near the central meridian of the sun's disc. The probability against such a connection being the result of chance is enormous. The number of days is six thousand eight hundred; but if we give two days for each spot at the central meridian, the probabilities against three agreements of three thousand four hundred are overwhelming. Take two boxes, and put all the numbers from

one to three thousand four hundred into each. The problem is to determine the probability that three numbers drawn haphazard from each box will give the three highest from each." Now if we apply this same reasoning to what has been done in multiple parentage, it seems equally certain that these varieties have not been raised haphazard.

The same results have followed each experiment, so that instead of this probability being confined to one case, we have every separate experiment to bring into the calculation. This reasoning may not be usual with Botanists, but it is mathematically correct. How many microscopical observations have been considered to have proved certain facts, and yet how many of these facts have had to be discarded on account of subsequent microscopic investigation? It seems to the author that microscopic research may not succeed to a remote decimal of the truth with any more certainty than by mathematical reasoning in such difficult cases as those we are now considering. Watching the various movements in the impregnation and germination of Ferns, which must be so much hidden by the folds of a cluster of prothalli, and also in keeping them alive and in health during such a severe trial, and being fortunate enough to be able to examine that *one* prothallus in a thousand that was able to produce multiple parentage, is almost like the calculation of an eclipse of the sun, from the three bodies moving through space at different speeds, in order to arrive at the exact time when all three will be in one and the same straight line. It may be done, and accomplished satisfactorily by one of our specialists; but the probability of being able to examine the identical prothallus whose female cell is about to receive sperms from several other prothalli is so remote that but few microscopists will venture on such an investigation.

The mode of reproduction varies with different animals and plants. In the higher classes of animals almost perfect

development takes place before the birth of offspring. In birds, eggs are laid, and the mother keeps them warm until they hatch. The toad deposits eggs in water, these develop into tadpoles, and after a time become young toads. The butterfly brings forth eggs, from which caterpillars issue, change to the chrysalis state, and afterwards emerge as fully grown butterflies. Fish deposit a mass of ova, which are *afterwards* fertilised. The slug is hermaphrodite, each pair of individuals laying eggs. Bees are male, female, and workers; and passing down to near the bottom of the scale, we have amongst protozoa, &c., a simple reproduction by the breaking of the individual into fragments.

In plants, flowers are formed, having male and female organs (stamen and pistil), which eventually produce seeds. These flowers may be dicœcious, *i.e.*, unisexual flowers of the same species produced on distinct individuals, as in the *yew* (where we have male and female trees); if monœcious, the two kinds of unisexual flowers are on the same plant, as in the *cucumber;* but there are a vast number of the species in various genera that are hermaphrodite, where the stamens and pistils are present within the same perianth, as in the *cowslip.* Descending in the scale, we have Ferns forming spores on the fronds, which germinate into prothalloid life, having the organs of generation that reproduce the frond life showing a double existence. It is not therefore difficult to conceive that we have here a distinct arrangement of hermaphrodite reproduction, or the spore growth (prothallus) having a number of archegonia (female cells), each containing a central cell (oösphere), and a number of antheridia (male cells) filled with spermatozoids. Why should not more than one of these archegonia attract swarms of spermatozoids, and, all being on the same prothallus, why may not this effect be diffused through the whole prothallus by assimilation, and thus cause multiple parentage?

ADDITIONAL EXPERIMENT NO. XLVIII.

On October 12, 1894, a pan (marked A) was planted with prothalli of a Scolopendrium, and on November 12 a second (marked B); the plants are a quarter of an inch apart, and are carefully protected from insects. On the 25th of January no fronds had been formed, but the prothalli in A were much larger than those in B. On that day several skipjacks were introduced into B. On February 11th every prothallus in B had formed fronds, whilst those in A were still in the prothalloid condition. In both pans the prothalli would have male and female organs, as they were undivided; nevertheless the skipjacks have accelerated the formation of fronds.

DEDUCTIONS AND PRACTICAL HINTS.

Granting that the certainty of multiple parentage is difficult of microscopic proof, owing to the practical impossibility of seeing through the microscope what really occurs, this absence of actual observation is far from justifying a refusal to accept conclusions otherwise abundantly established by experiments which show that the offspring bear unmistakable resemblance to all the parents.

Independently of the microscope, what are the reasonable conclusions established by these numerous experiments? Briefly:—

1st.—That more than one female cell on a Fern prothallus is capable of producing Ferns.

2nd.—That more than one spermatozoon has assisted in the impregnation of one or more of these cells.

3rd.—That a prothallus can be divided into four, and each portion can produce a separate plant.

4th.—That in quartering a prothallus there is evidence that the organs of only one sex are retained on each of these quarters.

5th.—That until two of these quarters are brought close enough to each other so as to coalesce, there can be no impregnation.

6th.—That if two of these quarters have thus been brought together without frond life resulting, each must have had the organs of one sex only.

7th.—That if afterwards a third quarter is made to coalesce with the former ones, and impregnation then takes place, the last quarter must have had the organs of the opposite sex.

8th.—That these *three* quarters having produced *five* plants, more than a single cell on one or other of these quarters must have been impregnated; if not, two of these quarters certainly will have contained only the male organs.*

9th.—That the divisions of a divided prothallus can live more than seven years if unimpregnated.

10th.—That if three or four varieties have been sown together and some of the resulting seedlings have the peculiarities of all the parents, the male sperms will have travelled to a different prothallus.

11th.—That these last results are not the effect of a previous cross, for two reasons—first, because the resemblances are confined to those varieties sown together; and secondly, that the seedlings, no matter of how many generations of crosses, if sown singly, will only produce the likeness of the Fern sown.

There is one question worthy of consideration to which these experiments give rise, it is this, two or more cells on the *same* prothallus have become impregnated. Will this cause *assimilation?* Will the effects produced in each cell become commingled? If so, instead of a cell requiring the

* As a matter of fact two had only female cells, and only one, male organs. This was ascertained by seeing two plants springing up from one division, three from another, and none from the third, the one which had been placed so as to coalesce with the others.

sperms from three distinct varieties to produce the characters of four parents, sperms from three varieties might be deposited in three separate cells, and assimilation produce the same result.

A few words must be said with respect to the best method of sowing spores. There are many ideas on this subject. The late Mr. John Smith of the Royal Gardens, Kew, had a rough and ready plan, always available at a moment's notice. He had a short plank of wood, coated with an inch of a moist stiff clay, which he kept in a damp frame. His plan was to scatter spores in this frame, saying a sufficient quantity would settle on the board to produce a crop. This plan, however, is not adapted for isolated sowings. Mr. G. B. Wollaston of Bishop's Well, Chislehurst, furnished Mr. Fox of Brislington with the following recipe: "Leaf mould or well-rotted dung from an old cucumber bed (three years old), one part; top spit or healthy loam, one part; heath mould (not bog earth), one part. Mix well together, adding enough silver sand to make the whole thoroughly friable. Brickbat pulverised is an excellent addition to the sand, or even road dust (avoid lime rubble in any form). The above compost suits Ferns of all ages, and forms a good top dressing." Mr. Wollaston advises *early* pricking out from spore-pans, as of great importance—not singly, but in small patches at first, so as to give room for development. Mr. E. F. Fox described his method: "Procure a good-sized bell-glass, also a large pan without any drainage holes at the bottom, in which the bell-glass may fit easily; procure a number of small pots sufficient to fill up the area enclosed by the glass when it is placed on the said pan. Make up a soil for the pots consisting of a little loam, sand, and leaf mould, with a trifle of good peat and some crushed-up old brick. Fill the small pots one-third full with drainage-crocks; place a little moss on the top of the crocks; then fill

up with your soil; press it down gently and firmly. See that there is a small space left within the inner side of the pan and the bell-glass—this is for the purpose of putting some packing between the glass and the pan.

"Having filled the small pots, place them on a sieve, then water them *thoroughly* with *boiling* water from a common watering-pot with a fine rose; repeat this application, then allow them to drain and get cool. When cold, bring them into a room, and be sure to have no open windows, that there may be no draughts of air, as the atmosphere must be quite still. Take each pot separately and away from the others, *label* it, and powder the spores over it. (*N.B.*—It is of course known that good spores are most prone to adhere to the paper enclosing them, whilst mere spore-cases run over and away from the paper with facility.) When all your pots are sown and labelled, arrange them in the pan, and place the bell-glass over them, being careful in so doing not to disturb the soil. When you have placed the pan in some shady place, take a good, clean, and damp sponge, tear it up, and pack it between the bell-glass and the pan. These pieces of sponge must be kept just full of water that has been boiled and allowed to get cold; the quantity of water constantly added will draw underneath the surface of the pots and supply them with sufficient moisture; be careful at all times not to flood the pan. This use of boiling water is for the destruction of all animal and vegetable life, thus giving room for the spores to make their growth undisturbed. Never remove the bell-glass for three or four months. You will see a gradual appearance of growth spreading over the surface of the pots, and some time after this minute fronds; you may then insert a bit of slate beneath the glass, and this is the first air they get; increase the allowance of air, and eventually remove the bell-glass. Never water overhead until the growth is considerable, or the Ferns will damp off."

Colonel Jones used very large pans, a similar but much coarser compost, and covered with a flat glass. This proved more successful than the plan adopted by Mr. Fox. There is less confervoid growth; and if the prothalli are attached to pieces of crock or lumps of soil, they can more readily be removed to other pans.

Dr. Fox's method as regarding the boiling water is not effectual, as was proved by many losses from conferva. It requires the pans to have been plunged at least three times into boiling water, and each time left in the water for ten minutes. The water applied as Dr. Fox suggests is some degrees below the boiling-point when supplied through a small watering-pot rose. If there are damp decayed leaves in the compost, worms get between them, and the author has seen them uninjured after two immersions in boiling water. Care must also be taken to destroy any vegetable life on the pans, bell-glasses, or labels.

It is difficult to mix a really good soil for seedlings, and it is better to have a number of different mixtures, and sow spores in each, in order to be more certain of success. For the author's own sowing he uses what are called pint pots, placing them in saucers with an inch of water for two or three days, and then removing this water for a day or two. He also uses good peat alone, and upturned loam sods alone, and sometimes one treatment is the best, and sometimes another. Most Ferns germinate very slowly in peat. Turf gathered where spring tides come over it will not have any growth either of Ferns or conferva. Practice and constant attention to every detail are sure to succeed eventually. Major Cowburn of Dennel Hill, and Mr. F. C. Clark of Street, were proficient at once, because they mastered all the details at starting.

In a paper that the author wrote for the January 1878 number of the *Midland Naturalist*, on "Abnormal Ferns,"

allusion is made to growing spores in a very dark place. The impregnation of the prothallus did not seem capable of being accomplished without the action of light; the growth seemed to be arrested before arriving at that particular stage of prothalloid life. The following experiment is an illustration. In 1874 a large Wardian case was filled at the base with three inches of a prepared compost, carefully pressed down, and this was sown in lines with spores from many varieties of different species, the lines being kept separate by moving flat glasses over the soil, only exposing that portion that was about to be sown. After sowing, the case was placed in a somewhat dark corner, under a brick archway, in a warm greenhouse that faced the north, the opening of the arches facing the south, the case being on the floor. When the spores had been sown about six months, the surface of all those lines was a green mass of prothalloid growth. A second case was then prepared, into which were transplanted rows of patches from each of the lines from the first Wardian case, every patch being lifted on the point of a knife, and deposited in a small hole previously made. This second case was placed in a light part of the same house where there was no sunshine. The transplanted patches grew rapidly, whilst those in the case from which they were taken made little or no progress. Within the next six months the second case was filled with a mass of fronds, but not a frond had appeared in the first case. For three years the first case was kept in the same dark situation, and there was but little increase in growth, and no fronds ever appeared; whereas all the little patches that were from time to time removed into full daylight rapidly developed fronds. These experiments were not then carried on beyond three years, but have since been repeated. The prothalli, although growing very slowly whilst in the dark, kept in a very healthy condition. Whilst making these experiments, a pan of transplanted groups, protected

with a bell-glass, was placed under the same arch, and as long as it remained there no fronds appeared.

Regarding the proper time for sowing spores there is a diversity of opinion: some advocate keeping them till spring; it has always been the practice of the author to sow as soon as possible; and as to the portions of fronds desired, they are placed in papers, and left between the pages of a book for a couple of days, when they would readily scrape by using a blunt penknife. At the time of getting the fronds, pans are prepared, so as to be in a proper condition as regards the necessary moisture of the soil. These seed-pans are always kept in a warm greenhouse until the prothalli are large enough to be repotted, and even then still kept for a time in a greenhouse. On potting singly, the plants are allowed to remain in heat for two or three weeks, after which, if the weather has become mild, they are placed out of doors. If the weather is cold, they are kept in the same house, or when strong enough are removed to a cool greenhouse or frame.

The author has constructed shallow two-light frames, using the Willesden waterproof green scrim instead of glass. These act the same as glass, are much lighter, less expensive, and are at the same time a shade. In these are placed about four inches of a porous material, usually the fine riddlings of coal after it has been burnt, and in this the seedling Ferns are plunged and flourish. This scrim is also an excellent shade for Fern-houses, and, being waterproof, it wears longer than the usual shading. It is the only shade that the author uses for Filmy Ferns.*

As regards insects, many are of interest to the Fern-grower. There are a number that may be constantly seen moving about amongst the prothalli; they are very small, and

* The new patent varnished wire-canvas is an excellent substitute for glass, durable, and is useful also as a shade.

difficult to eradicate, but appear to do no harm, and they may convey the sperms from one prothallus to another.* They are not found amongst wild prothalli out of doors. Wood-lice (*Oniscus asellus*) are a destructive pest, as they get under the glass and make themselves nests amongst the seedlings; they are readily seen and removed; a saucer of water surrounding the seed-pans is an effectual barrier.

The crane-fly, or daddy-long-legs (*Tipula oleracea*), is sometimes a pest, especially in the Bünter formation, where in July and August (as in Nottingham Park) the winged insect is seen in millions.

Beetles never troubled the author. Birkenhead's beetle-traps will catch them; but not wood-lice or slugs. The grub of the weevil (*Curculio sulcatus*) is exceedingly destructive to young *Scolopendriums*, and even to fully grown plants; they feed on the roots until none are left and the plants are dying before their ravages are found out. The only plan is occasionally to pull at the fronds, and if they are attacked by weevils, one or more will be found disconnected with the plant. When this is the case, all the soil must be shaken off, and the grubs found and destroyed. A hunt should be made for the perfect insect, as it is often detected in the daytime resting on the sides of the pans, or hidden under the leaves; at night it may be found crawling about. Some years this weevil is much more destructive than in others. In the spring of 1890, on new soiling a bed of *Aspidiums*, many thousands of these grubs were found. On taking up the large plants and shaking off the soil, it was seen they

* Amongst these *Podura plumbea* (skipjack), of the order *Thysanura*, family *Podurellæ*, evidently carries the male sperms of Ferns from one prothallus to another, and thus causes a strange impregnation. This insect was seen under a bell-glass that protected a division of a prothallus that had lived six and a half years without producing fronds because it had only the female organs, but three weeks afterwards a frondlet appeared. It is not only remarkable that a prothallus should live six and a half years, but that it should be in a condition for impregnation.

had fed very much on the roots; but the plants all recovered. Again, in 1891, on repotting the specimen *Adiantums*, it was found that these grubs had eaten into the very hearts of the plants, so that the specimens were divided by them into small pieces. The author counted as many as one hundred and seventy in one *Adiantum* pan, and there was not a single plant that had not dozens of these grubs. Although their ravages caused the plants to be some time in recovering, most of them were saved. Other small flies and beetles are destructive to the fronds. An insect known as the frog-hopper (*Thrips ochraceus*), from its snipe-like flight, feeds on the upper green surface of the fronds, very much disfiguring the *Polypodium vulgare*. It is readily observed on touching a frond, as it instantly flies off and settles on the under-side of that or another frond. Varnished wire-netting (a substitute for glass) is invaluable as a frog-hopper trap, owing to the stickiness of the varnish. Tobacco water, fir-tree oil, and fumigating kill these insects; but others arrive, and have to be continually looked for. The froth-hopper or cuckoo spit (*Teltigonia spumaria*) is only occasionally found on the fronds; it is recognised by its froth. The red spider (*Acarus tellarius*), the mealy bug (*Coccus adonidum*), the oleander scale (*Aspidiotus nerii*), thrips (*Thrips adonidum*), and the plant louse (*Aphis, several species*) are all more or less troublesome when the Ferns are in a greenhouse.

As regards destructive slugs, the author wishes particularly to except the *Testacella haliotidea* (Draparnaud), and its varieties *scutum* (Sowerby), *pallida* (Cockerell), and *aurea* (Cockerell), and also *Testacella Maugei* (Ferussac); these are friends instead of foes; they are easily recognised by the small shell on the top of the slug at what we may call the tail end, though in reality this is not the tail. In 1882 the author sent a number of specimens to his friend Dr. Gwyn Jeffreys, for he had found them in abundance at Shirenewton, Chepstow, Newchurch,

Wentwood, Matherne, Tintern, St. Pierre, Portskewet, Newport, Cardiff, Clifton, and Bath; but Dr. Jeffreys considered them to have been introduced. Since Dr. Jeffreys' death they have been seen in so many other localities that they are now considered as British slugs. They live underground in the daytime, and are only to be seen on damp nights by the aid of a lamp. They are very voracious; one kept in a box with ten worms and ten slugs had destroyed them all in two days. They descend worm-holes and will seize the worms, whilst the shell at the other extremity is a perfect protection against anything following them.

Of the eighty-seven land slugs there are only eighteen that give trouble to the gardener: these are *Amalia marginata* (Müller), *A. gagates* (Draparnaud), *Arion ater* (Linneus), *A. Bourguignati* (Mabille), *A. hortensis* (Ferussac), *A. subfuscus* (Draparnaud), *Eulimax agrestis* (Linneus), *E. maximus* (Linneus), *E. cinereo-niger* (Wolf), *Helix aspersa* (Müller), *H. concinna* (Jeffreys), *H. hispida* (Linneus), *H. hortensis* (Müller), *H. nemoralis* (Linneus), *H. rufescens* (Pennant), *Zonites alliarius* (Müller), *Z. cellarius* (Müller), and *Z. nitidulus* (Draparnaud). Some of these species have many varieties—*Arion ater* has 10, *Helix aspersa* 20, and *Helix nemoralis* 23. *Helix aspersa* is a great pest, but the author has never found it on the Keuper districts.

The slugs of large size are very destructive, and require to be constantly hunted for, or they will return night after night to the same plant. The *Adiantum* and *Scolopendrium* are the Ferns that suffer most. One visit at night is not sufficient, as some are on the move early, and some late. All slugs, wood-lice, centipedes, and many other insects * feed

* One of the most useful insects is the ladybird (*Coccinellæ*). There are several common species, and they should be collected for the greenhouse, as they live on nearly all the insect pests. The larva of the ladybird is very voracious. The author placed two of them on a pelargonium that was swarming with *Aphis* (green

with avidity on bran steeped in vinegar, and this is a better trap than lettuce or cabbage leaves. If small heaps of the bran are deposited in a score or more parts of a Fern-house, the slugs will prefer feeding at these heaps to destroying the fronds, and two or three visits each evening will soon clear the house of slugs; it is far better to find food for depredators, instead of waiting night after night for them to be trapped. The author never could see the philosophy of setting a single trap along a row of peas that mice were destroying; for, whilst one is being caught, the others will be going on with their work of destruction. If, instead of this, you were to scatter a little corn amongst the peas, the mice would eat the former, whilst at the same time you are gradually reducing the number and saving your crop. In setting vinegar and bran traps in the outdoor Fernery, the author has caught more than two thousand slugs in a night with fifty of these little heaps: early in the night these traps are visited by some dozen distinct small slugs, whilst at a later hour large ones appear. Slugs that are so rare in a certain locality as not to have been noticed have been secured by this means.

There are various vegetable as well as animal pests: the most destructive is one very similar in its ravages to that which causes the potato disease. It is a fungoid growth that is known in Scotland, and in the last few years has appeared in England. It was first seen in Mr. E. F. Fox's Fernery at Bristol, six years ago, from which it has spread to the

fly), and on looking at it an hour afterwards there was not one remaining. It must not be omitted, in the enumeration of insects, to point to the disfigurement of fronds by large and small caterpillars: one, if left undisturbed, will soon leave nothing but the thick stems; another will have its egg deposited in the unfolded frond of the Lady Fern, the apex of which will afterwards be discovered rolled up into a bundle in which the grub may be found; a third is detected eating its way up the Lady Fern stem; whilst a fourth (very small) glues itself in its network meshes on the under-side of the fronds.

author's Fernery, and into that of the Clifton Zoological Gardens. It does not show itself out of doors until the middle of summer, when dark patches appear on the fronds, which are at once much disfigured. If all the fronds are severely attacked, the plant becomes so weak that it is unable to recover. The author has it in his greenhouses, where it attacks even the small seedlings, and in a warm greenhouse it grows and spreads through the winter. The only way to stamp it out is by cutting off all the diseased fronds as they appear, and at once burning them. Its ravages are chiefly confined to the *Scolopendrium;* but it will attack other Ferns, especially the Lady Fern and *Nephrodium spinulosum;* and indeed other plants, as in the spring of 1892 it was found on the leaves of the dahlia and tomato that were growing in the same house with the author's seedling Ferns.* An orange-coloured fungus† attacks the *Cystopteris*, and occasionally mildew may be seen.

We read in the *Gardeners' Chronicle*, Dec. 24, 1892 :—

"A new pest attacked *Aspidium angulare* (but no other Fern) on the 10th of June 1894, and for a few days did great damage. The rachis at different heights was scraped to the centre, and this caused the frond to break at the injury; the costa of the pinnæ were also similarly attacked. What produced this damage was not discovered. It was noticed both at Shirenewton Hall and at the Clifton Zoological Gardens.

"Specimens of the fungus greatly resembling that found on the potato, which were sent to Dr. Maxwell Masters, were reported on by Mr. Cooke, who considered 'it was apparently *Milesia polupodii*, found first in Scotland, but not before known in England. The filaments are like those of a moss, long drawn out, resembling those of *Fontinalis antepyretica*.'"—*M. C. Cooke, Herbarium, Royal Gardens, Kew.*

* The *Milesia* was all but absent in 1893, no doubt owing to the drought, but it played fearful ravages with the Hart's-tongue Fern in 1894.

† *Fuligo varians.*

The author cannot help quoting, from Mr. Druery's useful work on "Choice British Ferns," the following remarks, as they are so true, which we all know to our cost, viz., as regards destruction of plants through want of ordinary observation and attention. Mr. Druery says: "With constant personal care the evil may not go far; but go out for a week or two, leave somebody else in charge, and the caterpillar gets his chance. When you return home, it is possible you will find a choice selection of rags and tatters of dilapidated Fern fronds, and a fine army of caterpillars roosting upon the ruins, and busily grinding up the remnants into future butterflies; your pet plants recalling Paddy's old coat, *i.e.*, composed principally of fresh air." Prevention is better than cure; but how is this to be attained if your gardener is devoid of that bump of observation that would enable him to detect these ravages before the whole plant is gone into the stomach of the caterpillar? Plants may swarm with green fly and mealy bug, and a whole colony of different plant pests, but he either does not see them or is too busy with his previously neglected cabbages to have time to destroy pests till to-morrow, which, however, never comes; he forgets that he is thus aiding in the destruction of all the plants under his care, and, moreover, is building up for himself a character of incompetence; adding one more instance that such a man "is not worthy of his hire," and that instead of his swaggering, and priding himself on what the army of proficient gardeners, however, call by the names of want of brains, and destitution of ordinary abilities, he should rather take his seat on a back form in a Board School, and try to learn at all events as much as his child, who was not born a dozen years ago.

Watering young fronds is a delicate operation; for if the small fronds are weighed down to the soil, unless immediately lifted up by the point of a knife or pin, they

will be destroyed. A very fine rose must be used with the watering-pot, so as to imitate a gentle shower; and whilst in the prothalloid state, or when the first frondlets are only then appearing, if moisture is required it must be given through a spray distributor.

In potting off young Ferns into single small flower-pots, it is an advantage to use cockle-shells or broken oyster-shells with the drainage, and above this a thin layer of spent-hops: when the roots reach these they begin to grow vigorously, and they continue to receive this nourishment after removal into larger pots.

The labels for Ferns are of importance, from the sowing of the spores to the mature plant.

The author's practice with the spores has been to paint the centre of the flat covering glasses *white*, and, whilst wet, to write the name or names, and the date. If the seed-pan contains three or four different varieties of spores, or mixed spores, the glass is marked with these three or four divisions, and the names of the spores contained in each, together with a private number.

For the ordinary Fernery label, various kinds have been tried, and all but the one now adopted have been more or less failures. When a label will only be legible for twelve months, the readings having become illegible before the label itself is decayed, all the work must be renewed each year, and, with thousands of plants, this labour is very great. Three years ago the author had labels made half-an-inch thick, an inch and a half wide, and ten inches in length; these were kept square at the bottom, and made smooth. One half of the label received three coats of white paint, and the other half was dipped in boiling tar;* when dry they were painted on one side, over

* A creosote-mixture has been used lately, the base of the label being plunged into it for a few hours, apparently with success. Recently the author has been using iron labels one inch wide, and ten inches long, which are painted white, and

the white paint, with black Japan, and before this had become dry the name required was scratched in with a blunt-pointed piece of hard wood or a French wire nail; this caused the letters to appear white on a black ground. These square-ended labels were then driven firmly into the ground. The object in having the label blunt instead of pointed was to prevent the frost lifting it out of the ground, as happens if the label be wedge-shaped; and in this respect it has proved successful. Labels made three years ago are as sound and legible as the day they were made, and rain keeps them clean. A second safeguard is entering the position of the plants in the Fernery in a catalogue: if this is carefully done, you are independent of labels. At the Clifton Zoological Gardens this plan has been adopted by the author, on account of the danger of exhibiting the names in a garden so much frequented. Occasionally a plant has been stolen, and it has been thought that if the plants were exhibited with their names the loss would be greater. The plants are all in rows, and are divided into sections by the introduction of dwarf-standard yew-trees, the record always beginning at the east end of each row in every section.

Aspidium angulare var. *decompositum-splendens* has great interest attached to it on account of its anomalous seedlings with much-divided superb fronds, for up to the present time there is no knowledge of any of the seedlings bearing any likeness to its parent. A short history of this Fern is desirable on account of some confusion that exists as regards its origin. The honour of discovering this Fern has been erroneously stated by Mr. C. Druery to belong to Colonel Jones. This is an excusable mistake, because two Ferns now bearing this name were found. A variety called *decompositum* was found in Devon by Mr. Moule, and a seedling raised from it by Colonel Jones was named *decomposi-*

afterwards the name scratched in on a black Japan surface. These, if cut from good hoop-iron, are not expensive.

tum-splendens; and the plant is not bulbiferous, nor does it produce varieties like the *plumoso-divisilobum.* A somewhat similar variety has been found in Ireland, in County Down, by Mr. W. H. Phillips. However, the true or original *decompositum-splendens* was found by Mr. James Moly of Langmoor, Charmouth, in one of his tours into South Devon in 1875, and it received this name from Mr. G. B. Wollaston. Colonel Jones gathered spores from this plant in Mr. Moly's garden, and these were sown in 1878 by Mr. E. F. Fox, though the latter was not aware till long afterwards that they were not from Colonel Jones' seedling. The anomalous character of the seedlings raised from these spores was so marked that Mr. Fox was unwilling to credit *decompositum-splendens* with being the parent. Colonel Jones therefore made a special visit to Mr. Moly for additional spores, and was at the same time presented with a division of the plant, which is now in the Martin-Atkins Fernery in Pembroke Road, Clifton. In 1892 Mr. Moly's plant produced a bulbil, which he presented to the author, and this accounts for the seedlings of *decompositum-splendens* being more or less bulbiferous.

The second sowing of these spores by Mr. Fox confirmed the fact that the former anomalous seedlings owed their parentage to his *decompositum-splendens.* Amongst the first seedlings were three somewhat similar in character, yet distinct from each other; these Colonel Jones named *plumoso-divisilobum laxum*, *plumoso-divisilobum robustum*, and *plumoso-divisilobum densum*, all very fine varieties, the last-mentioned being the most beautiful, in fact as beautiful as *Todea superba.* They are all sterile, and require propagating by bulbils or divisions, the latter being a very slow process. As regards the propagation by bulbils, the one known as *plumoso-divisilobum densum* has bulbils that produce very different varieties to the parent. Colonel Jones raised two plants from bulbils in 1886, and in 1888 gave one to the author, and the other to Mr. John Loraine Baldwin. They were not

only distinct from the parent, but quite distinct from each other: the one given to the author has almost horizontal fronds, and this has been called *imbricatum;* the other has an erect frond, narrower than the others, but the divisions are much finer; this has been called *Baldwini*, and is, perhaps, the most beautiful British Fern yet known. From the second sowing by Mr. Fox, there was only one that was very distinct, this is called *gracile.* Mr. Fox all but lost it, and gave it to the author to try and save its life; it lingered between life and death until the summer of 1894, when it threw up some healthy fronds. The author sowed spores of this *decompositum-splendens* in 1890, and has a few promising varieties. It has been said that all these three varieties are sterile, yet in 1893 there were a few spore-cases on *Baldwini;* they were very different from the normal ones of *Aspidium angulare*, having no indusium, and were small, showing, when magnified, that each had only four to five spores; these were at once sown, but it is not yet certain that any have germinated.

The varieties of *Aspidium angulare* in the section *plumoso-divisilobum* must not be confused with those in the section *divisilobum:* for in the latter there is a variety *laxum*, found by Mr. J. Wills, in South Devon in 1874; another, *robustum*, found also in South Devon in 1874, by Mr. J. Moly; and a third, *densum*, which was raised at Sale by Messrs. F. W. & H. Stansfield.

In 1879 the author raised a number of seedlings that all belong to the section *plumoso-divisilobum*, but how they originated it is now impossible to say; they were small when he left Nottinghamshire, and showed nothing remarkable in their character, and they passed into the hands of Messrs. J. R. Pearson, and were grown in their Nursery at Chilwell. In 1885 Colonel Jones visited Chilwell and recognised their excellence, and brought some plants away with him. But previously to this others had been disposed of that Mr. Charles Pearson thought were the cream of this batch; these were traced to the King's Norton Nursery near Birmingham, and the author

obtained a plant of the best variety from Messrs. Pope & Sons. Colonel Jones named three of the varieties *Pearsoni*, *dissectum*, and *Lowei*, the latter being the one from King's Norton.

In the second sowing of *decompositum-splendens* by Mr. Fox, the seedlings were very similar to those first raised.

In 1885 Mr. Fox sowed a mixture of *decompositum-splendens* with a variety known as the *plumosum* of Wollaston, and amongst the seedlings are *plumoso-divisilobum grande* (Jones), and *Raina* (Fox).

In 1885 Colonel Jones also sowed a mixture of spores consisting of *decompositum-splendens* (Wollaston), *polydactylum-Jonesii* (Lowe), known as the Hampshire Polydactylum, and *splendidum* (Lowe), the Vale of Avoca Polydactylum of Padley; the idea was to raise polydactylous forms of *plumoso-divisilobum*. In this Colonel Jones succeeded; but all the varieties were congested, and the cresting proved to be no improvement, as it was at the expense of the divisions of the lobes.

In 1890 the author sowed a mixture of the spores of *decompositum-splendens*, Mrs. Grant's beautiful *plumosum*, and Colonel Jones' *lineare-cristatum*; there are varieties from this mixture having *plumoso-divisilobum* characters that are crested and yet not congested.* There would have been many sowings of *decompositum-splendens* on account of the great interest attached to this variety, but the difficulty has been to procure spores. Mr. Moly, in his good nature, divided the plant so that Colonel Jones should possess a portion of it, and unfortunately this injured Mr. Moly's plant, whilst the one Colonel Jones had has been lost. Major Cowburn, Mr. Barnard Hankey, and Mr. Barnes all had spores, but failed to raise plants.

In 1894 Mr. Moly had only one frond with spores; and of the last sowing of the author, though there were many seedlings, none had characters like *plumoso-divisilobum*—it seems as if the power to produce plumose fronds from some reason or other has been lost.

* Seedlings from sowings in 1891 and 1893 are very promising.

The many and very varied ways in which Ferns can be raised are of great interest, and should make the subject one of especial interest to Botanists. The numerous distinct and handsome varieties of the British species have kept up an interest with Horticulturalists; the advance owing to hybrid varieties has been vastly greater than that by wild finds; the former have rapidly increased, whilst the latter have decreased; the Fern explorer, who used to be laden with new varieties, now returns empty-handed, and it is only whilst we have new fields to explore that we may hope to obtain something new. Many of those who formerly employed their leisure in exploration, now find it more profitable to devote their time to the raising of crossed varieties.

Speaking of bulb-bearing Ferns, *i.e.*, plants forming on the fronds, these are to be found at the base of the stipes of *Aspidium angulare*, and in some varieties also along the rachis, for more than three-fourths of the length of the frond. Mr. O'Kelly found a *Scolopendrium* in County Clare with the upper surface scattered over with small plants; and the author has a plant very like *S. vulgare* var. *quadriparens*, with plants on the leafy portion. He once saw a crested *Osmunda regalis* similarly bulbiferous, and in this instance (as in *A. angulare* above mentioned) the bulbils did not produce plants like the parent; indeed, from this crested variety a *grandiceps* variety resulted. Some years ago the author received from Miss Bellaires a large specimen of the Axminster form of the plumose Lady Fern, with the fronds crowded with young plants; more than fifty could be counted on a single frond. These bulbils have nothing to do with the sori reproduction, as they are as common on the sterile as on the fertile frond.

There is a congested capitate *Aspidium angulare* in the Fernery at Shirenewton Hall. If its fronds are buried in soil up to the capitate head, roots are formed, and the capitate head can in a few months be divided into a number of plants.

It is a well-known fact that Ferns with capitate fronds, after

being fully unfolded, will again commence to increase the size of the head, and sometimes to a considerable extent.

It has been suggested that information should be given as to where at the present time are the best places as hunting-grounds for new wild varieties, and here difficulties crop up: those places that used to be the most prolific in abnormal forms have been so well explored by the Botanist and Florist, and so thoroughly examined by the Fern-dealer that there is very little chance of finding a really distinct new form. It is a good rule to select localities difficult of access, thinly populated districts far removed from railways and the usual routes of tourists; these are now the most promising places. A large wood near a road full of Ferns will be searched from the nearest side, and such a place would only yield treasures at the furthest extreme. Inaccessible rocks, or rocks where a ladder has to be used, will yield better results than where plants can be reached from the ground. In the wildest districts in Scotland, Ireland, Wales, and England, far removed from large towns, there are yet places to be found that will reward an explorer. Even at the time when Fern-hunters found so many good varieties, a long day's search would be considered a successful one if one really distinct form was secured; though there are instances where the discoveries have been far more prolific. Some years ago Colonel Jones, Mr. Praeger, and the author took a carriage to explore the country near the sea from Minehead to Ilfracombe, avoiding as much as possible the well-known coach-road. The first day was spent between Minehead and Lynton, and the second between Lynton and Ilfracombe; but although many varieties were seen, there were none that could be said to be remarkably distinct. We had previously had a blank day's hunting between Nettlecombe Court and Dunster Castle, and afterwards an equally fruitless search near Cullompton, in Devon. The author has examined parts of Dartmoor, Saltash,

Torbay, Dawlish, and Westward Ho, but the finds have been disappointing. The coast-line between Scarborough and Whitby was a greater success years ago; but Killin, Ben Lawers, Ambleside, Dunkeld, Arbroath, and between Loch Katrine and the Bridge of Allan have been the author's experiences of really good districts for Fern varieties, and about the Falcon Clints in Teesdale, Weardale, and Wensleydale, near Stonyhurst, and Chaigeley Manor, Lancashire, all used to be prolific hunting-grounds. A second visit along the Yorkshire coast and in Teesdale was disappointing. It must be remembered that such researches are now less successful, owing to the number of fine varieties that have already been discovered. Take as example the fork-headed and capitate *Scolopendriums*, where in the neighbourhood of Dawlish and Westward Ho there used to be so many; if now equally abundant, it would be impossible to find varieties that would in any degree approach what have been already found or raised. And it must also be remembered that, having now so many very distinct extreme forms, plants raised from them (two or more varieties crossed together) give a far greater chance of splendid results than months of diligent exploration in wild districts. One of our most active explorers, who has hunted for Fern varieties for many years, Mr. James Moly of Langmoor, near Charmouth, says that the author has raised many forms that he has been hunting for in vain, and that he consoles himself with the knowledge that some of these could not have been raised had he not found the varieties from which they have sprung. It must not be forgotten that the surroundings of many of these wild localities are so beautiful that an enjoyment exists apart from what may be discovered. To those who admire nature, and especially those living in large towns, these changes not only contribute to health, but distract attention, in a pleasurable manner, from those business turmoils that are a constant strain upon the brain.

Some of the islands around our coast have yielded many good Ferns: the Channel Islands, Arran, and other of those islands along the west coast of Scotland and Ireland have given good varieties; and if we take as an illustration the number of species of Ferns that are to be found in the limited area of some of these islands, we become astonished at such fertile spots. Taking Lundy as our example, we have an island of 3½ miles in length, from north to south, and under a mile broad where widest; it is situated 19 miles outside Barnstable Bay, and has precipitous cliffs. The loftiest mountain is Beacon Hill, 525 feet in height. For the most part it is a rocky table-land exposed to the blasts of the Atlantic gales; it swarms with innumerable sea-birds, but the only animals are rabbits and rats. Although so small, and separated 19 miles from the mainland, there is a plentiful supply of fresh-water springs. Amongst the flora the following Ferns inhabit Lundy:—

Adiantum Capillus-Veneris (rare).
Asplenium Adiantum-nigrum.
„ *Filix-fœmina.*
„ *lanceolatum.*
„ *marinum.*
Aspidium aculeatum.
Cystopteris fragilis and variety.
Lomaria Spicant.
Osmunda regalis.
Nephrodium Filix-mas.
„ *rigidum.*
„ *recurrum.*
„ *spinulosum.*
„ *dilatatum.*
Polypodium vulgare.
Scolopendrium vulgare.
Pteris aquilina.
Ophioglossum vulgatum.

Ferns undergo great changes in the vigour of their growth, according to a greater or less favourable situation. The author has found *Pteris aquilina* on the summit of Helvellyn with fronds only three inches in length, and on Longridge Fell exceeding ten feet. *Polypodium vulgare*, *P. dryopteris*, *P. phegopteris*, and *Nephrodium alpinum* vary from one to three inches, and *Nephrodium abbreviatum* bore twelve-inch fronds on Ben Lawers. *Asplenium marinum* in the sea-caves at Auchmithie,

on the east coast of Scotland, was much reduced in size, and the *Osmunda regalis* on rocks dashed with waves near Santander was only three or four inches in height, whilst in some parts of Ireland it attains the height of eight or ten feet. The Lady Fern becomes stunted in growth on exposed mountains, and attains the greatest luxuriance when growing on the margin of brooks in sheltered situations. The late Sir W. J. Hooker considered that the growth of *Adiantum Capillus-Veneris*, and *Asplenium marinum* as he found it in the Burren district of County Clare, could only be compared to their luxuriance in Madeira. The author in 1860 gathered fronds of the Maiden-hair Fern whose length was thirty inches, amongst rocks on the summit of the Vilia Escusa, one of the spurs of the Pyrenees in Northern Spain.

The difference between a species and a variety is difficult to denote, as there are changes from the normal form that may have been occasioned by time and altered circumstances; and again, there are what may be termed the normal form of a district, as a species varies in its character in different places—in one place the growth is luxuriant, in another it is stunted—and this frequently means a greater or less development in all the details of a frond. There are places near Scarborough where the Hart's-tongue exists as a dwarf, misshapen plant; and there are other places within a distance of two or three miles where the soil is damp, and the plants are protected from the sun and wind, where they assume gigantic proportions; but these divergences cannot be looked upon as varieties, only as of greater or less luxuriance owing to the soil and surroundings. The same reasoning equally applies to other species. What we look upon as varieties are confined to those where the changes are far more distinct, and where the difference can be seen at a glance.

If two species are successfully crossed, their offspring will be hybrids, but not if the crosses are between two varieties

of the same species; and the great test is in these crosses, for the seedlings from crossed varieties are as fertile as their parents, whilst those between two species are practically sterile: this is shown in the offspring that have been produced from crossing *Aspidium angulare* with *Aspidium aculeatum*, or from the want of success in sowing the spores of *Nephrodium remotum* (known in gardens as *Lastrea remota*) and *Asplenium microdona*.

For many reasons it is desirable to enter into details as regards the cultivation of Ferns, and to point out what may be injurious to their successful cultivation, and thus to render assistance to those who are desirous to make this study a success. Fifty years' experience emboldens the author to offer advice, and to give that information that has proved so successful in his own investigations. Where the cultivation of Ferns is attended with success it gives an interest that lasts throughout the summer; whereas with most other plants it is only the delight of a few days.

The general notion of a Fernery is the accumulation of stones to form a Rockery, and the interspersion of a little soil. The Ferns planted under such circumstances are often too dry, and the first scarcity of rain is more or less fatal to them, so much so as to cause them to drag on a miserable existence. Ferns love water at their roots and a humid atmosphere, and most of them require a shade—though not an overhead shade which will prevent the rain falling on their fronds. Some Ferneries are in borders on the north side of trees, and this will suit them until the roots of the trees spread amongst the Ferns and extract from the soil that which should feed the Ferns. The most suitable place for nearly all Ferns is a border on the north side of a wall, though some species do well if exposed to the sun. There are times of drought, when under the most favourable circumstances watering is an absolute

necessity, and in such instances it should be given copiously, as a mere sprinkling does no good, the benefit only lasting a few hours. If it is merely a wet surface, evaporation soon carries it away; but if the ground is thoroughly wet to the depth of four or five inches, the action below the surface is slow. For bog Ferns, a low part of the Fernery well flooded twice a day will be a good substitution for a marsh. After a few dry days in summer the ground becomes parched, and it requires water equal to that of a thunder-shower to do away with this dryness. When it is requisite to resort to outdoor watering, gardeners are apt to give too little. In 1893 the drought dried the ground to the depth of nearly two feet. In the midst of this drought there was a thunder-storm, which threw down more than one hundred tons of water per acre; but this great amount only penetrated the ground to the depth of one and a half inch, and four days afterwards the effect had gone. The drainage-pipes that carry off the water into brooks had no water in them till December 4, as it took all the autumnal rain to moisten the ground. The rain from a thunder-storm after the surface ground has become dry has great difficulty in penetrating the ground, and a large amount of the water runs on the surface to a lower level.

Some Ferneries are planted without any regard to the requirements of the different species. *Osmunda regalis*, *Nephrodium cristatum*, and *Nephrodium thelypteris* are bog plants, and delight to be in a situation where their roots can descend to the water. They can all be successfully grown by copying nature, either by making a bog with water and clay, and then growing the plants in pots placed on small mounds; or by burying a large pan in the ground that will hold water below the roots.

The *Asplenium Trichomanes*, *A. viride*, *A. ruta-muraria*, and *A. Ceterach*, if grown out of doors, require a rockery built against a wall, looking towards the north, and raised

six or seven feet above the ground. The surface of this rockery should have a mixture of stones and soil six or eight inches in depth. Seedling plants will do well in this; but plants gathered wild from a wall are almost certain to have their roots damaged when gathering them. All the *Aspleniums* do well grown in pots in a cool greenhouse with sufficient ventilation. The *Asplenium marinum* is not hardy, except where it naturally grows in a cave; here it clothes both the sides and the roof, even where there is only a scanty supply of soil. It is to be seen growing along sea cliffs, for here there is not sufficient cold in winter to destroy the plants. In a greenhouse, however, it is sure to flourish. The *Polypodium alpestre* and the *Aspidium Lonchites* are both mountain Ferns; their roots run along the ground, and are easily gathered without damage; but they are rather difficult to cultivate; potting without pressing the soil, and giving a liberal supply of water, is essential; out of doors stones should be above them, the roots under, and the fronds rising just outside the stones. *Asplenium septentrionale* grows amongst crumbling rocks, and as it is a Fern that requires peculiar rocks, it is wiser to bring away with the plants a supply of the rock and soil. Potted in its native soil it will flourish in a greenhouse.

The Killarney Fern (*Trichomanes radicans*) is another Fern that requires special treatment: it is impatient of drought, and grows well where it can enjoy the spray of a waterfall. It is found at Killarney and several other places in Ireland, and has been found on the Welsh coast, both by the late Mr. Backhouse and by a Fern-hunter who was endeavouring to find out where Mr. Backhouse had seen it. More recently it has been found in Scotland. If the following plan is adopted, it will flourish as well as in its natural habitat. Dig a pit 4 feet deep, and if not through a rock or heavy clay, the sides will require walling —it should not be less than 12 feet long and 6 feet wide; on this

fit a framework and glass lights, and if the soil is porous, have a concrete bottom extending several inches up the sides so as to hold water; use large shallow pans filled with broken rock, and a surface of a couple of inches of peat and sand, to grow the plants; fasten them down to the soil, and in course of time they will spread their rhizomas both on the surface of the pans and all round the outside; these pans should stand in a saucer of water, and the whole placed on a large inverted flower-pan; water frequently with a watering-can or a small rose, and cover the glass with Willesden scrim, and in frosty weather throw two or three thicknesses of mats over the lights, and no further protection is necessary. The author has some splendid specimens that were potted more than forty years ago and never since disturbed.

Todea superba and *Todea pellucida* do well in this pit, as also the *Hymenophyllums;* the latter, if tied with wire on the outside of inverted flower-pans, will require no further help. The sides of the pit which the author has, have become covered with self-sown Ferns, amongst which are young plants of the *Todea pellucida.*

Nephrodium montanum is found from the sea-level to a considerable elevation. Both this and *Lomaria Spicant* are difficult of cultivation in a limestone district; they require much water and a total absence of lime; a mixture of cold stiff clay and decaying leaves suits them well.

Nephrodium Filix-mas, N. paleaceum, N. abbreviatum, Asplenium Filix-fœmina, Aspidium angulare, and *A. aculeatum* are all easily grown; they require a mixture of heavy loam and decaying leaves, with abundance of space between the plants in order to produce good specimens. It is advisable to cover all the Fern-beds with a liberal supply of leaf mould every winter; it prevents the frost freezing the ground hard, and is a fertiliser in the spring.

Nebhrodium, Filix-mas, N. paleaceum, and *N. abbreviatum*

were formerly considered as only forms of *N. Filix-mas* until Mr. Wollaston pointed out the specific differences. The great difficulty of crossing any two of these, proves them to be species. From many sowings the author raised only three plants, whilst a portion of the spores (from the same papers) when sown separately produced a great number of plants.

The largest plant of *Nephrodium abbreviatum* that the author has found was growing near the summit of Ben Lawers, not much under the height of four thousand feet. A number of very distinct varieties of this species have been found in the English Lake district.

Nephrodium spinulosum, *N. alpinum*, and *N. æmulum* are, according to some authorities, three distinct species, but according to others are only forms of *N. spinulosum*. There seems to be a close affinity between the first two, *N. alpinum* being a dwarf mountain form of *N. spinulosum*. As regards *N. æmulum*, the fronds are quite different, they are so tough that they are only broken with difficulty; whilst the others have very brittle fronds. *N. æmulum* is also a mountain form. In a hilly wood at Hackness, the basal half was, twenty years ago, crowded with *N. spinulosum*, which at the bottom of this hill were of an unusual large size; higher up they became smaller, and then a few plants of *N. æmulum* were found amongst them; higher up *N. æmulum* was more abundant, and *N. spinulosum* in much diminished numbers; and at a few feet higher than this the *N. spinulosum* ceased, and a large number of *N. æmulum* seemed to take exclusive possession. The author removed a large number of plants of the *N. æmulum*, but yet left thousands. These were planted in two large beds in which there was a liberal supply of half-decayed leaves, in which the plants flourished, and grew into much larger specimens than any that could have been gathered at Hackness. These were exclusively *N. æmulum*, but in the second year

several of the largest were unmistakably *N. spinulosum.* Year after year a greater number of *N. spinulosum* appeared, and in six or seven years every plant on these two beds was *N. spinulosum:* there was not a single plant of *N. æmulum* to be seen. Three years ago Mr. P. Neill Fraser sent the author a dozen Scotch plants of *N. æmulum,* and this year three of them were *N. spinulosum.* None of the plants of *N. æmulum* grown in pans have changed their character. It has been suggested that plants of *N. æmulum* died, and seedlings of *N. spinulosum* had sprung up in their place. Were this the case the plants of *N. spinulosum* would at first be smaller than the well-grown specimens of *N. æmulum;* instead of which, wherever a plant of *N. spinulosum* appeared, it was always fully grown, and larger than the plants of *N. æmulum.* With these repeated proofs, it is more difficult to believe that *N. spinulosum* had taken possession of these beds, than that the plants had changed their character. The above plants grow best in almost pure leaf mould.

The *Ophioglossums* and *Botrychiums* are small, not very conspicuous, and do not keep in good order for any length of time; and, moreover, they only succeed when planted amongst the grass in a meadow. Take this hint, and keep them in their favourite fields.

Polypodium vulgare is easily managed if grown with an abundance of leaf mould and half-decaying wood; but the fronds are apt to be disfigured by the frog-hopper.

Pteris aquilina succeeds well if placed in the Fernery as an established plant, although it is difficult to remove it from its wild habitat. It is a greater success to have slate or slabs of stone enclosing a space, three feet in diameter, and one foot deep; by this means the underground rhizomas keep within the desired limits, and form a handsome close bush, instead of single fronds appearing here and there all over the Fernery, often smothering other Ferns.

Cryptogramma crispa and *Polypodium Robertianum* should be

planted with more stone than soil, and stones should surround them ; the latter may be found growing amongst heaps of stones without any soil.

Cystopteris fragilis and its varieties grow well in soil if there is plenty of limestone.

The *Woodsias* and *Gymnogramme Leptophylla* must be grown in a cool greenhouse under hand-lights.

Cystopteris montana, which is abundant amongst grass on ledges of rock on Ben Lawers, is very easily cultivated in pans in a greenhouse ; it soon makes a good specimen.

Polypodium Dryopteris and *P. Phegopteris* succeed well if planted in leaf soil on a surface of cool clay. In a shady greenhouse *Adiantum Capillus-Veneris* must be treated as a greenhouse plant ; it does not flourish out of doors, but planted in pans of about twelve inches in diameter, and with half the compost consisting of old cow manure, magnificent specimens can be obtained.

Throughout the winter and in early spring the deciduous Ferns are frondless, and even the evergreen ones have scarcely any fronds that are not disfigured ; but at this period a British Fernery may be made attractive by planting the different narcissi between the Ferns, and having a margin of crocus and snowdrop. If the Ferns are three feet apart, and the centre eight or nine inches between each Fern is planted with a dozen bulbs of any kind of narcissus, an interesting collection of narcissi may make the Fernery gay in spring ; and before the fronds of the Ferns have come to maturity the leaves of these bulbs will have disappeared, and therefore they will not cause any detriment to the Fernery.

The love of flowers is universal, it is to be seen in every country, and it was so hundreds of years ago ; and there is a pleasing reference to narcissi attributed to Mohammed, who is stated to have said, "If any one has two loaves of bread, let him sell one and buy narcissi."

The material used in potting Ferns is of great importance, as on this depends the success attained. Peat, loam, leaves, clay, sand, broken stones, crocks, half-decayed wood, lime, manure, shells, spent-hops, cocoa-refuse, &c., must be used.

In the first place, the flower-pots and pans must be quite clean and dry, or a confervoid growth will soon appear, and this is injurious to the plants.

Proper drainage is necessary; a hollow crock should be placed at the bottom, and then a layer of broken crocks, and above this a thin layer of cocoa-refuse, and some broken sea-shells, with a little sprinkling of spent-hops. The pan is then ready for the compost, which must be varied to suit the different species. It is scarcely necessary to state that the amount of drainage should be increased according to the size of the pan, very small pans requiring scarcely any drainage.

The different materials should be kept in separate heaps, and only mixed as desired at the time of potting. The peat, loam, clay, half-decayed wood, and old cow-manure should be kept in heaps on the north side of a wall, and kept clean from weeds. As regards leaves, they must be carefully collected as soon as they fall; those from the oak and other deciduous plants are to be preferred; they should be in a heap not more than a foot thick, and turned over every week for some time to prevent their getting warm; afterwards they may be stacked, but should still be occasionally turned over. Clay should be collected in the autumn, and on the approach of frost, spread thinly on the ground; this will cause pulverisation with a few degrees of frost.

The sand selected should be coarse; fine sand is scarcely wanted. The broken stones will be required of different sizes, from that of a nut to that of several inches in diameter—sandstone, limestone, and Keuper-clay to be kept separate. Crocks from broken flower-pots should be of several sizes, being separated by passing through riddles with an inch mesh, half-

an-inch, and a quarter of an inch. Half-decayed wood must not be from small branches; it should be eight or ten inches in circumference, and stacked with the bark on. After a gale there is plenty of all sizes to be found. The lime may be a mixture of broken-up limestone and old mortar.

The manure should be that collected from the pastures known as dry cow-manure, which should be stacked out of doors. The best broken shells are those of oysters and cockles. Spent-hops can be procured at a brewery, and cocoa-refuse from one of the numerous dealers in peat, sand, loam, &c. A leaf-heap must be made every year, as it will be required of different ages, as some Ferns prefer half-rotten leaves. In potting, the soils should be passed through a riddle, and only the coarse portion used, except near the surface; this is very essential with large plants, for if potted entirely in fine soil, the plants will suffer; the lumps should be pressed close, but not the fine soil.

A mixture of half loam and leaf, with a third of sand, and a third of broken-up cow-manure, will suit most Ferns; with the addition of lime to those that require it, and the absence of lime where it is injurious.

Constant attention in watering and watching for insects, slugs, &c., is of the greatest importance. It is as easy to give too much water as too little. If the soil of a plant has become very dry, watering is of no use, as it runs through the pan, only wetting one or two places; the pan should be plunged above the rim in water, and left there till all the bubbles of air have been forced out.

The growing of Ferns is more general than it used to be. A few years ago there was no special British Fernery at the Royal Gardens, Kew; but one has now been added through the solicitation and earnest desire of a few of the Fern cultivators. Colonel Jones, Mr. E. F. Fox, and the author have sent a number of their varieties to the Kew Gardens, and Mr. Carbonell of Usk left his Ferns (by will) to be added to

that collection. Many new varieties are constantly being found wild or are raised from spores, and it is desirable that duplicates of these should find a home in this national collection.

Recently a Fernery has been added to the collection of plants in the Royal Botanic Gardens at Glasnevin, and the author has supplied a number of plants in order to improve this Irish Fernery.

Although some notable Ferneries have ceased to exist, owing to the death of the owners, others have been formed. In the author's younger days there were Mr. Swynfen Jervis's collection, and those of Mr. James of Vauvert, Mr. Clapham's of Scarborough, Mr. Monkman's of Malton, the Rev. Charles Padley's at Bulwell Hall, Mr. Wills's of Thornscombe, Mr Moly's. of Langmoor, Mr. R. J. Gray's at Exeter, the nursery collections of Mr. Sim of Footscray, Mr. Stansfield's of Todmorden, and Mr. Ivery's of Dorking; more recently, those of Mr. E. F. Fox at Brislington, Mr. Barnard Hankey's, and others: all but one have ceased to exist.* Colonel Jones's Ferns were presented to the Zoological Gardens at Clifton, and are a very fine collection; those of Major Cowburn are taken care of by Mrs. Cowburn, and Mrs. Grant's at Hillersdon by her son, Lord Llangattock. Captain Marling of Clauna and others near Chepstow have formed Ferneries, and Mr. F. C. Clark of Street is growing crossed varieties from spores. Although we have lost many cultivators of Ferns, their choicest varieties are still to be procured, and the newer varieties, more especially those raised by crossing, are in great advance of those of former days; the slight varieties that used to attract attention being now passed over as unimportant. Many named varieties have been superseded by seedlings. Formerly any one finding or raising a dozen new varieties was looked upon with

* *I.e.*, Mr. Moly's of Langmoor, Charmouth.

envy; but now Ferns with strikingly distinct characters are raised in great numbers.

The immense number of spores that are constantly being driven about by the wind is incredible. Two years ago the author filled half-a-dozen seed-pans with suitable compost, and placed them in exposed situations for a few hours, and then covered them with sheets of glass so as to prevent other spores occupying these pans. In course of time the surface was covered with prothalli, and in a few months later the crop showed plants of the Oak Fern, Marsh Fern, Lady Fern, Male Fern, Hart's-tongue, Bracken, Maiden-hair Spleenwort, &c. There were many plants of the Oak Fern, although none are growing in the neighbourhood.

When the author began to cultivate foreign Ferns, within a year twenty-seven species sprung up in a large pan in the Conservatory at Lenton Hall, where they had no Ferns, and which is a quarter of a mile away. In 1860 the rain-water off a walk was conveyed in pipes to a wall forming a sunk fence; the water came through the stones and kept them moist, and in a year or two the stones were hid by hundreds of Ferns, mostly the *Asplenium Trichomanes*, although this species was not to be found within several miles. Near the lake at Highfield House was a sandstone cliff covered with ivy; a portion was cleared to show the rock, and within two or three years the *Asplenium Adiantum-nigrum* appeared in profusion, although there were no plants of this species nearer than the rocks of Nottingham Castle. Another example at Highfield House was a holly-fence on a sunken wall planted on the eastern side of an orchard; this became the home of a vast number of the Hart's-tongue Fern, although this Fern did not grow wild anywhere near the estate. It is thus only necessary to form suitable situations with suitable soil, and Ferns will soon take possession. The pit formed for Filmy Ferns at Shirenewton Hall is cut through rock, and is four

feet deep; this pit is covered with glass, which is only lifted for the purpose of watering, nevertheless it is crowded with seedling Ferns.

If a collection is to embrace all the British species, there should be a greenhouse, the span-roof house is the best (with ventilation along the ridge), as in Messrs. Foster & Pearson's houses; the walk should be in the middle with a border of 6 feet to 8 feet on either side. There should be a wall on either side of 3 feet high, and the borders should be raised to this height, in which the plants can be plunged in their pots, and the glass roof should be covered with what is known as the Willesden scrim shade, which, although a perfect shade, does not make the house too dark. There are some delicate fronded Ferns such as *Acrocladon*, *Clarissima*, and *Kalothrix* varieties of the *Asplenium Filix-fœmina*, *Aspidium Lonchitis*, &c., that grow much more satisfactorily than in the open Fernery. Some Ferns, as the *Adiantum Capillus-Veneris*, and *Asplenium marinum*, require heat in winter.

We have elsewhere alluded to a Filmy Fern-pit. But there is yet another structure (in which young plants may be planted in lines to strengthen) which is extremely useful: it is a frame with a brick or wood side on the south, and lean-to lights on the north side; the lights should be 3 feet at the back, and 1 foot at the front, and within should be at least 6 inches of good soil in which the Ferns should be planted; the glass should be in separate lights of 3 feet in length, for easy movement, and should rest against uprights to prevent their being blown off by the wind.

There are great differences in the time occupied in the germination of spores, some species taking much longer than others; freshly gathered spores occupying the least time, and those that have been kept for a number of years germinating the slowest. After pricking out the seedlings, if the pans are kept, further seedlings will spring up, and these

are often quite distinct from the first crop. It must also be understood that many Ferns do not assume their distinct varietal character until they have become mature for several years, and this more especially applies to the Aspidiums. On the other hand, Ferns will show peculiar features when quite in their infancy, these features becoming more and more pronounced and improved with each unfolded frond.

It is not known how long spores retain vitality. Some that were gathered in 1887, and sown in 1893, showed life in at least seventy per cent. of the spores. The late Dr. E. F. Fox received spores from Dr. Allchin in 1873; these were sown in 1892, and a number (although a much diminished number) had retained vitality.

The male sperms may not have much power in extricating themselves from their cases, but they have some locomotive force *inter se*, this is observed in the *Vaucheria clavata*, which can stretch the walls of its confinement, and be squeezed out, although much larger than the orifice of the tube in which they are confined. This, however, is not a Fern.

A few words should be said as regards sterile Ferns—those in which there is an absence of any trace of sori, and those in which there are only imperfect spores. A *Scolopendrium vulgare* named *sterile*, found by Mr. J. Moly, is perfectly sterile, and there is not a trace of sori; it is normal in form, of large size, but with somewhat thin fronds.

The section *crispum* in *Scolopendrium vulgare*, with one or two exceptions that are less crisp and bear sori (*fertile* of Fox is one), are all considered sterile, and until 1894 the author had never seen any that did more than occasionally bear a few solitary sori. However, last year Mr. Clutson, gardener to Mrs. Cowburn, had a frond, in which the lower half was not only copiously soriferous, but there were twice as many lines of sori, and many of these were twice as long as usual; they ended suddenly in the middle of the frond, the upper half being

perfectly sterile (the variety is known as *crispum-Cowburni*). Advantage has been taken of this rare chance to sow a number of pans with the spores.

Some very beautiful varieties are sterile, and amongst these are *Aspidium aculeatum* var. *pulcherrimum*; *A. angulare* var. *plumosum-grande* (raised by Mr. E. F. Fox); *A. angulare*, var. *Pateyi*; *A. angulare* var. *plumosum* (Moore); the three forms of *A. angulare*, known as *densum*, *robustum*, and *laxum*, in the section *plumoso-divisilobum*; *Nephrodium paleaceum* var. *ramosissimum*; *Polypodium vulgare* var. *cambricum*; *Pteris aquilina* var. *grandiceps*; *Asplenium Trichomanes* var. *incisum-Claphami* (and several others of the *incisums*); *Asplenium marinum* vars. *plumosum* (Wollaston), *Thompsonæ*, and *multipinnatum*; *Asplenium Filix-fœmina* vars. *Axminsterense*, *Barnesii*, *Clarissima*, *Kalothrix*, *plumosum*, *Willsii*, and *crispum*. There are more that might be enumerated, but the above are some of the most beautiful of the British Ferns. The second class of sterile Ferns which have sori, but have no perfect spores, are hybrids, having only the rudiment of fertility without being fertile; we may instance *Nephrodium remotum*, *Aspidium hybridum*, *Asplenium microdon*, *Asplenium adulterum*, and a hybrid between *Asplenium Trichomanes* and *Asplenium ruta-muraria* which has been found by Mr. G. B. Wollaston.

Sterile Ferns can only be increased by division or by the formation of bulbils, and this in either case is a very slow process with most of them; they are some years before they throw up a second crown, and very few form bulbils. On the other hand, any one who will devote time and attention to the precautions that are set forth in raising Ferns from spores, can in five or six years form a large and interesting collection of Ferns which will teem with new varieties. There may be some failures, but experience will surmount all the difficulties, and the interest in watching the growth and development of the seedlings is the reward of this diligence.

MEMOIRS OF FERN HYBRIDISERS

COLONEL ARTHUR MOWBRAY JONES

Colonel Arthur Mowbray Jones, eldest surviving son of the late Thomas Mowbray Stafford Jones of Newport, Isle of Wight, and Madeira House, Clifton, was born at Ringwood, in Hampshire, January 8, 1826, and was educated at Bishops College, Bristol. He entered the army in 1849, and served with the 75th Regiment in India, in the Madras Presidency. In 1850 he exchanged into the 27th Regiment, then quartered at Stirling, resigning his commission in 1853. In 1854 he joined the West York Militia as Captain, when it was embodied during the Crimean War, and remained in this regiment until it was disembodied in 1856. He studied at Durham University for a short time, and also at the Agricultural College, Cirencester. In November 1860 Colonel Jones was appointed Adjutant of the 1st Volunteer Battalion the Gloucester Regiment, and held that post till 1881, when he became Lieutenant-Colonel Commanding, retiring in 1882 with the rank of Colonel. He commenced the study of Madrepores, &c., in 1858, and made a large collection, part of which he afterwards presented to the Oxford Museum, and part to the Bristol Museum.

He was married in 1864 to Clara, daughter of the late Edwin Martin-Atkins of Kingston Lisle, Berkshire, who predeceased him, leaving a family of four daughters and two sons.

He died on the 28th of February 1889, aged 63, and was buried in Redland Green churchyard, Bristol.

In 1867 he started his collection of Ferns.

In the present memoir the author has to refer more especially to his connection with British Ferns. He was one of the founders of the "Pteridological Society," a Society which authorised the publication of a certain number of *Nature-printed Impressions of the* Varieties *of the British Species of Ferns*, that were to be distributed to the members of the Society at a small (inadequate) cost. Before the first of this series was issued, the Society had ceased to exist, but between January 1876 and December 1880 these plates (between three hundred and four hundred in number) were issued, and the somewhat large additional expense was cheerfully borne by Colonel Jones. It had originally been the intention of the Rev. Charles Padley to produce this series, and his exceptional mastery of the subject well fitted him for this labour. He had selected Mr. Thomas Smith to execute the illustrations, and had caused him to be instructed in the best system of Nature Printing then in vogue; but Mr. Padley abandoned the project, and Colonel Jones then took it in hand and secured Mr. Smith's services. Mr. Smith had a natural taste for, and good knowledge of, Ferns, and this being combined with technical skill, he commenced a process never before attempted in that way, and excellently executed the plates. Through a pressure of business, however, Mr. Smith had to relinquish the work, and for the latter portion of this undertaking we are indebted to Colonel Jones and his sister and daughters, to whom Mr. Smith had communicated the details of his system of "Nature Printing," and who continued the production of the plates admirably.

Colonel Jones was passionately fond of Ferns, and in the latter portion of his life made frequent excursions to various parts of England, Scotland, and Ireland, in quest

of wild varieties; in some of these being accompanied by the author. He was widely known and justly esteemed by Fern cultivators, and added much to his collection by exchanging plants.

When the author sent a petition to the Board of Works asking for a Fernery to be constructed at the Royal Gardens, Kew, in order that a National Collection might be formed, Colonel Jones was one of those who not only appended his signature, but after the Fernery had been made sent a number of his varieties to Kew.

The Ferns more especially associated with Colonel Jones are *Asplenium Filix-fœmina* var. *Clarissima; Aspidium aculeatum* var. *Abbottæ*, which he saw in the garden of Mrs. Abbot of Abbots Leigh, near Bristol (who had found it); and *Nephrodium æmulum-cristatum*, which he raised from spores from a frond given to him by the late Mr. Gill of Lynton; but his greatest achievement was in raising (in conjunction with Mr. E. F. Fox) those beautiful plumose varieties of *Aspidium angulare* known as *plumoso-divisilobum* vars. *laxum*, *robustum*, and *densum*, raised from *decompositum-splendens* (a variety that had been found by Mr. James Moly). The first-mentioned *Clarissima* is a most delicately beautiful variety of the Lady Fern; it was found in North Devon in 1868 by Mr. Moule, and the plant was secured by Colonel Jones, who gave it the above name, saying it was named after his wife, "the Clara of all Claras."

A few years before Colonel Jones's death he presented the bulk of his collection of Ferns to the Clifton Zoological Gardens, where they are now, carefully tended by Mr. Harris (the head gardener), under the superintendence of the author. It is a grand collection, and a valuable addition to the attractions of Clifton.

It was not till 1884 that Colonel Jones commenced repeating the author's experiments as regards multiple

parentage, and adding others of his own; but he soon showed himself master of the subject, and not only confirmed the author's statements, but very materially strengthened the proofs. He had persistently defended the practice of using Latin descriptive (and even compound) names that had been commenced by others when varieties were very few in number; and it was only a short time before his death that he began to realise the difficulties which were presenting themselves, especially as regards using compound words. The night before he died he posted a very long letter to the author, in which he concluded by saying, "If you come over to Clifton on Saturday, I think that an hour's conversation in the 'Gardens' will be enough to convince me that your notions are correct, and that descriptive Latin names will have to be discarded in future." Before this note reached the author, Colonel Jones had passed away.

In 1888, during a severe frost, the author fell in Bristol and broke his arm. Colonel Jones took him to his house, where he remained his guest for six weeks, during which time his anxiety to entertain an invalid, and his constant care and attention, even to himself bringing a cup of tea at four o'clock each morning, will always be remembered with affectionate gratitude.

With Colonel Jones's death the author lost his greatest friend, one whose experience and sound judgment could always be relied upon. His kindness of heart, his encouragement to all those that were following in his footsteps, and his intense feeling of the honour that should mark every gentleman, are traits of his character that can never be forgotten.

*** The following are extracts from letters received from Colonel Jones and Mr. E. F. Fox,* two well-known British Fern authorities, having had for many years large collections. Colonel Jones, whose letter was written the day before

* See also p. 179.

his death, said, "If you will come to Clifton on Saturday, I am prepared to be convinced by a short conversation that your views regarding nomenclature are correct. I have been following Moore, who has led all of us astray; but we must recollect that when he started giving varieties Latin names, they could be counted on his fingers. The varieties are now too numerous for us to perpetuate descriptive Latin names. Your discovery of multiple parentage (every step of which I have myself proved) is such a revolution that the time has now arrived for the disuse of Latin. You cannot alter old-established names, but you can prevent compound words in future nomenclature. Turning to genera, Baker of Kew has discarded *Athyrium*, *Polystichum*, *Lastrea*, and *Blechnum*, for *Asplenium*, *Aspidium*, *Nephrodium*, and *Lomaria*. Several of my Fern friends say this is wrong, though Moore has convinced me that such alterations are not without reason. *You* will not be hard on our errors, as some twenty years ago you followed Moore in 'Our Native Ferns.'"

E. F. Fox

Major Cowan

Colonel A. M. Jones

A. Clapham

John E. Mapplebeck

W. J. Collins Sc.

EDWIN FYDELL FOX

Edwin Fydell Fox was born on April 20, 1814, at Brislington House, near Bristol. He adopted the medical profession, and passed his examinations with distinction. His specialty was mental disease, and he was considered very clever in his profession in cerebral complaints. Mr. Fox was the medical man in attendance at the Brislington Lunatic Asylum. He died March 12, 1891, and was buried at the Rookery Cemetery, Brislington, belonging to the Fox family, and formerly the property of the Society of Friends.

Mr. Fox began cultivating Ferns in 1869, when he made the acquaintance of Colonel Jones; he took up the subject with great interest and zeal, and formed a very large collection of plants.

He began crossing Ferns in 1884, and was eminently successful. It is difficult to separate what he did from what was done by Colonel Jones, as there was a kind of partnership in their experiments. Colonel Jones often brought mixtures of spores to sow, and eventually the spoils were divided. Among the best successes were three Lady Ferns—*Evelyna*, *Nellie*, and *Helena*: these Mr. Fox named after members of his own family, saying that he "would set an example that long descriptive Latin names were not now to be tolerated, although he himself had been a culprit, having been led astray." He used to declare that had he known twenty years ago what he then knew, that varieties of British Ferns were going to be more like swarms of Bees than Solitary Wasps, he should have set an example earlier. His great favourite was *Aspidium*

aculeatum, and he crossed its varieties in as many ways as their limited number permitted, being rewarded by raising good varieties. It was Mr. Fox who sowed *decomposita-splendens*, and produced those marvellous plumose forms of *divisilobum* of *Aspidium angulare*, but how he had accomplished this he was not able to say; in fact for a long time he could not believe that Colonel Jones had given him *decomposita-splendens* spores. After another sowing, when others, gathered from the same plant and mixed with spores of *polydactylus*, had produced polydactylous forms of *divisilobum*, he was convinced. He raised a very fine variety from the author's *euprepes*. One day when the author was dining with him he spoke with great confidence as to a number of seedlings that were beginning to show marked peculiarities, although yet infants; a few days after, he wrote saying that if alive and well in June, when new fronds had been developed, he should like to thoroughly examine every one of them, adding (although then well), "If I should die before then, come at once and take these seedlings away with you." A very few days afterwards he had passed away, and these seedlings were added to the Shirenewton collection by Miss Fox's desire.

Mr. Fox found a good fertile form of *Scolopendrium vulgare* var. *crispum*, from the spores of which the author has raised distinct varieties. His sterling and far-seeing abilities made it a pleasure to visit him at his hospitable home; it was impossible to spend even an hour there without gaining some useful knowledge, or without feeling that he also appreciated what others were doing. Mr. Fox was a firm believer in multiple parentage. He used to say that he had been a microscopist for more than sixty years, and had worked out very difficult problems, but that they were all as nothing in comparison with the chance of detecting, by microscopic aid, the impregnation of a Fern in a conclusive

manner; "It could, however, be seen by overwhelming evidence, this was accomplished; and although specialists might hesitate, it was nevertheless a truth that would have to be acknowledged."

Mr. E. F. Fox, writing soon afterwards, remarks: "I am altogether with you as regards the use of English names for varieties, in fact I have adopted it in *Evelyna* and *Nellie*, two of my newest seedlings, and with others, since Colonel Jones and yourself had such a long interesting discussion in my house. Your last experiments on multiple germs and sperms have only again proved what you had previously asserted. Colonel Jones and myself have repeated most of your work, and have proved that you had accomplished this when you exhibited a gradation of varieties, the result of mixed spores from *any two varieties;* for had impregnation taken place in the manner specialists describe (*i.e.*, one germ and one sperm), you could not have produced a gradation of forms; and as to the notion that the results were from former crosses, if this were true you could raise seedlings with characters totally unlike what was sown. Occasionally rogues will appear that have nothing to do with the spores sown. Your plan of brushing loose spores from the fronds, after having been pressed for a day, gets rid of stray spores without destroying many of those belonging to the frond. Hankey, Moly, Cowburn, and Fred Stansfield support your views; but our friend Wollaston (?)—well, he begs to differ. Your new Handbook is admirable. I am delighted to see that you have stated *Abbottæ* to be an *Aculeatum;* it certainly is one, though poor Jones called it an *Angulare*."

Although well on in years, he worked with keen interest to the last, leaving others to finish what he had so well begun.

MAJOR THOMAS BRETT COWBURN

Major Thomas Brett Cowburn, J.P., was born at Sydenham, in Kent, on the 16th of November 1839. He came to reside at Boughspring, Tidenham, near Chepstow, in May 1856. He was gazetted to the 52nd Light Infantry, December 19, 1857; went to India at the time of the Indian Mutiny in 1858, landed at Kurachee, Bombay, and marched to Delhi. He was in Central India five years, and came home with his regiment, then ordered to Limerick. Major Cowburn left the regiment in 1868, but in 1869 was appointed Adjutant of the 1st Monmouthshire Rifle Volunteer Corps (2nd Volunteer Battalion of the South Wales Borderers), and continued Adjutant till 1885. He married Fanny Sophia Morgan, daughter of Thomas Henry Morgan, Esq., in 1869, and went to reside at Dennel Hill in 1869.

Major Cowburn did not begin to grow Ferns until the beginning of 1888, though he was passionately fond of them, and used to express regret that he had not studied Ferns when in India, as he was in the midst of these lovely plants; he had been then more attracted by the flowering plants, and had brought some home with him. His fine collection of hothouse and herbaceous plants at Dennel Hill evidenced his great love for flowers. Although British Ferns did not occupy Major Cowburn's attention until 1888, he at once threw his whole energy into raising crossed varieties, repeating and extending the author's experiments, and doing this in so thorough a manner that, had his life been spared, great things would have been accomplished. Many of his

seedlings are only now showing their true characters, and it is gratifying to know that Mrs. Cowburn has continued the cultivation of her husband's collection, and is taking intense interest in their welfare. Only last week the author received from her fronds of a seedling Lady Fern that is a distinct lax form of *setigerum*, and this was from spores that Major Cowburn had sown.

At Mr. E. F. Fox's death the Brislington collection was sold, and some of the choicest varieties were purchased for Dennel Hill.

Major Cowburn found those beautiful crisp Hart's-tongues now known as *Cowburni* on one of his own walls at Dennel Hill; it is to him also that we are indebted for the introduction of Mrs. Boyle's *Nephrodium paleaceum* var. *crispulum*, as well as for other important finds. The author received valuable aid from Major Cowburn in many ways, especially in hints as to what should be tested as exhaustive experiments, and the author always looked forward with pleasure to his visits, and he knew this was reciprocated.

Major Cowburn took great interest in the Fern Conference, and accompanied the author to give assistance. He also took a leading part, in conjunction with other lovers of Ferns, in the 1892 Fern Show of the Royal Horticultural Society; but he had died before the Show took place, and his loss was deeply deplored. He was a kind and cheerful companion, a wise magistrate, and took great interest in the welfare of his less fortunate neighbours; a true and hospitable friend, and a good man.

ABRAHAM CLAPHAM

Abraham Clapham resided on the South Cliff, Scarborough, where he had a valuable collection of Ferns. He was very fond of Fern-hunting, and at one time this occupied much of his time. Although for some years he could not be induced to believe in the possibility of crossing Ferns, nevertheless he raised a number of good varieties, and satisfied his own views with the belief that these certain varieties were apt to sport. Many of his best Ferns were in a Fern-house, and although he was very careful in isolating his spore-pans, what he called rogues had been deposited on the fronds from which he gathered his spores, and this must have been the cause of variation. More recently he became convinced that Ferns could be crossed, commenced raising seedlings, and produced grand varieties of *Polypodium vulgare*. Mr. Clapham's name will always be associated with *Asplenium Trichomanes* var. *incisum*, as a form of this which he found, and known as *Claphami*, is the most beautiful plumose Maiden-hair Spleenwort known. The capitate forms of the Sea Spleenwort originated from a variety found by him on the sea-cliffs north of Scarborough. From his Lady Fern *proteum* crossed with *Victoriæ* the author was able to raise many fine cruciate forms, and that marvellous Lady Fern *acrocladon* found at Castle Howard was in his fine collection. For many years this was sterile and very rare. Mr. Clapham eventually detected a few spores, and raised a number of prothalli, but he could not change them into their frond life ; he sent some to the author, asking

for other prothalli to be planted with them, as he thought they were without male organs. A portion were treated as requested, and a portion planted separately; from the former the author produced crossed varieties, and from the latter nine plants like *acrocladon*, proving that this apprehension was unfounded.

For a few years Mr. Clapham left Scarborough and resided in London; it was then that he parted with many of his Ferns, Colonel Jones, Mr. Barnes, and the author receiving his best; still, he could not relinquish his favourite pursuit, and occupied himself in raising seedling varieties. He hunted many parts of Yorkshire, the English Lakes, and Scotland, and he even found some varieties in Brittany.

Mr. Clapham was fond of trout-fishing, and used to combine this sport with Fern-hunting. He had also a natural taste for ornithology, and had a particularly fine collection of Hawks and Owls.

Since his death the author has lost sight of his family, and has no means of giving other details; he believes, however, that he descended from the Claphams of Settle, as he always spoke of Ingleborough as the home of his younger days. He lived to a good old age.

Mr. Clapham was one of the author's oldest friends, for it is nearly forty years since he first knew him. He was always willing to assist, and did contribute largely to his collection. Starting at a time when Ferns were not cultivated, except by very few, he may justly be called one of the pioneers of this interesting branch of inquiry.

JOHN E. MAPPLEBECK

John E. Mapplebeck was born at Birmingham, June 23, 1842. When twelve years of age he began pressing fronds, and spent much of his playtime in arranging dried specimens; but it was in 1859 that he was struck with the mania for collecting Ferns, partly excited through seeing a splendid lot of rare species brought by his sister from Kendal. After a time he thought there was great pleasure to be derived from the varieties which were not then very numerous. In 1862 Mr. Mapplebeck started propagating from spores, sowing two or three varieties together, but scarcely anticipating the results which took place. In 1863 he went to New Zealand for three years, and on his return found that some new varieties had sprung from his 1862 spore-sowing; and after that he continued the experiments, and making friends with several prominent Fern authorities, he got together a fine collection of new varieties, with which to experiment; while he was particularly indebted to his best of friends, the late Colonel Jones, whose death was a severe loss to him, for spores of many of the new varieties.

From 1868 to 1884 most of Mr. Mapplebeck's spare time was devoted to hybridising Ferns, by mixing two or three varieties, and the result gave him the greatest possible surprise and satisfaction; he mixed different *species* also together scores of times, but never raised a hybrid.

In 1873 Mr. Mapplebeck was elected a Fellow of the Linnean Society.

About 1888, owing to the illness of his wife, his atten-

tion and anxiety were devoted to her, and on her subsequent death he was too depressed to take that ardent interest in Ferns, the pursuit of which previously had been one of the greatest pleasures of his life. In 1891 Mr. Mapplebeck left Hartfield, Moseley, near Birmingham, for his present residence, Bronddwynant, near Dolgelly, North Wales, taking with him his best Ferns, and distributing vast numbers of others among his friends. In 1892 he married again; but his second wife died June 23, 1893, and his son was born on that day. It is a singular coincidence that he also was born on June 23. There are two daughters by his first wife. Mr. Mapplebeck has still a large collection of Ferns, but not such an extensive one as formerly.

Among the best of Mr. Mapplebeck's wild-finds are *Asplenium Filix-fœmina* var. *caudiculatum*, and *robusto-multifidum* (Moore), *cristato-congestum*, *Mapplebeckii* (Lowe), *Nephrodium paleaceum* var. *Mapplebeckii* (Lowe), *Lomaria Spicant* var. *ramoso-marginata*, and *Aspidium angulare* vars. *acrocladon*, *quadratum-reflexum*, *folioso-filipes*, and *pulcherrimum* (the latter found by him close to Mr. Moly's house near Charmouth).

From the large number of varieties that have been raised by Mr. Mapplebeck, the author can only quote the very best, viz :—

Pteris aquilina vars.—

grandiceps
Hartfieldii
ramo-cristata
glomerato-cristata
„ *grandiceps*
grandiceps-Mapplebeckii

Asplenium Filix-fœmina vars.—

achillæfolium
caput-Medusæ
cephalomanes
ceratophyllum
ceratophylloides
comicum
Craigii-glomeratum
defecto-sectum
eulophon
Elizabethæ
flabelliceps
flabellato-grandiceps
flabellifolium-tenue
flexile
fœniculatum-dispar
Gilsoniæ-flabellatum
Gilsoniæ-furcans
paucidentatum
pulchello-plumosum
Quilteri
ramulosissimum
spicatum
torto-cristatum

Between 1868 and 1872 Mr. Mapplebeck was a very successful exhibitor at the Royal Horticultural Society, and a friendly rivalry existed between himself and the author, sometimes one winning and sometimes the other; but it is to his independent experiments on crossing Ferns that we owe him so much, as he began only seven years later than the author, and long before any one else had thought it possible to cross Ferns. He is the only one now alive of the portrait group of hybridisers.

EDWARD JOSEPH LOWE

EDWARD JOSEPH LOWE, J.P. and D.L. both of Nottinghamshire and Monmouth, surviving son of Alfred Lowe, J.P. for Nottinghamshire, born at Highfield House, in the county of Nottingham, November 11, 1825, and removed to Shirenewton Hall, Monmouthshire, in 1880.

Elected F.R.S. in 1867; F.R.A.S. in 1848; F. Roy. Met. Soc. on April 3, 1850 (one of the Founders); F.G.S. in 1853; F.L.S. in 1857; F.R.H.S. in 1872 (as Honorary Life Fellow).

Hist. Nat. Nov. Ebor. et Lit. et Phil. Manc. Mem. Corr.

Member of the Conchological Society.

Hon. Secretary of the British Association at Nottingham Meeting, 1866.

Hon. Secretary of the Royal Horticultural Society at Nottingham Meeting, 1872.

Past Worshipful Master of the Royal Sussex Lodge of Freemasons.

Hon. Member of Nottingham Ancient Order of Oddfellows, and Acting Grand Master of England in 1866.

For many years Meteorological Observer for the Registrar-General, and reporter of Daily Telegraphs to Admiral Fitzroy and the Meteorological Office of the Board of Trade.

Discoverer of a new British Worm (*Megascolex rigida*, Baird).

Author of *Our Native Ferns*, *British and Exotic Ferns*, *New and Rare Ferns*, *British Ferns and where found*, *British Grasses*, *Beautiful Leaved Plants*, *Conchology of Nottingham*, *Climate of Nottingham*, *Atmospheric Phenomena*, *Magazine of Natural Phenomena*, *Earthquake of October* 6, 1863, *Cycle of the Seasons*, *Barometrical Tables of Corrections*, *Meteorology of Morton's Farmer's Calendar*, *Meteorological Instruments* (*Orr's Circle of the Sciences*), *&c.*

Many of the illustrations are from Photographs by H. L. P. Lowe, J.P.

THE SPECIES OF BRITISH FERNS

(Sir W. Hooker's "Synopsis Filicum" completed by J. G. Baker, F.R.S.)

Adiantum Capillus-Veneris, *Linneus.*
Aspidium aculeatum, *Swartz* (section Polystichum).
„ angulare, *Kitaibel* (section „).
„ Lonchitis, *Swartz* (section „).
Asplenium Adiantum-nigrum, *Linneus.*
„ Ceterach, *Linneus.*
„ Filix-fœmina, *Bernhardi* (section Athyrium).
„ fontanum, *Bernhardi.*
„ Germanicum, *Weiss.*
„ lanceolatum, *Hudson.*
„ marinum, *Linneus.*
„ Ruta-muraria, *Linneus.*
„ Septentrionale, *Linneus.*
„ Trichomanes, *Linneus.*
„ viride, *Hudson.*
Botrychium Lunaria, *Swartz.*
Cryptogramme crispa, *R. Brown.*
Cystopteris alpina, *Desvaux.*
„ fragilis, *Bernhardi.*
„ montana, *Link.*
Gymnogramme leptophylla, *Desvaux.*
Hymenophyllum Tunbridgense, *Smith.*
„ unilaterale, *Bory.*
Lomaria Spicant, *Desvaux.*
Nephrodium abbreviatum, *Lowe* (section Lastrea).
„ cristatum, *Michaux* (section „).
„ Filix-mas, *Richard* (section „).
„ montanum, *Baker* (section „).
„ paleaceum, *Don* (section „).
„ rigidum, *Desvaux* (section „).

Nephrodium spinulosum, *Desvaux* (section Lastrea).
„ Thelypteris, *Desvaux* (section „).
Ophioglossum lusitanicum, *Linneus.*
„ vulgatum, *Linneus.*
Osmunda regalis, *Linneus.*
Polypodium alpestre, *Hoppe.*
„ Dryopteris, *Linneus.*
„ Phegopteris, *Linneus.*
„ Robertianum, *Hoffman.*
„ vulgare, *Linneus.*
Pteris aquilina, *Linneus.*
Scolopendrium vulgare, *Smith.*
Trichomanes radicans, *Swartz.*
Woodsia hyperborea, *R. Brown.*
„ ilvensis, *R. Brown.*

INDEX

INDEX

Printed by Ballantyne, Hanson & Co.
Edinburgh and London